TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XIII, No. 2. FEBRUARY, 1936. PRICE 6d.

CONTENTS.

	PAGE.
Sea Island Cotton	29
Coconut Husk Ash as a Fertilizer ..	30
Some Notes on Cotton in Colombia ..	31
"Aerial Wells" and Soil Moisture ..	34
A Variety Test in Sugar-Cane	35
Charcoal Manufacture from Coconut Shell ..	36
The Incidence of the Large Moth Borer, *Castnia Licus*, in Wild Plants in Trinidad	37
Investigations on Sugar-cane and Sugar-cane soils in Antigua	38
Correspondence	47
Empire-grown Sisal for Marine Cordage ..	47
Reviews	48
The New Low Temperature Station in Jamaica	49
Parasitism of Rhizoctonia Lamellifera, *Small*	49
Chemical Notes	50
Sugar Notes	51
Trend of the Markets	52

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C.3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

SEA ISLAND COTTON.

It will be remembered that about three years ago the West Indian Sea Island cotton industry was in a very precarious condition and that to devise means for establishing it on a sounder basis a Cotton Conference was held in November 1933. The main outcome of this Conference was the formation of a West Indian Sea Island Cotton Association which may claim to have played a major part in the rehabilitation of the industry. Thanks to this organisation funds were collected and applied to several useful purposes, production was temporarily restricted and an Advisory Committee appointed in England which has done and is doing a great deal to further the interests of the industry. In particular may be mentioned the acquisition and successful establishment of a certification trade mark for the protection of Sea Island cotton goods, the organisation of research into possible new uses for Sea Island cotton and the encouragement of an extensive and profitable advertising campaign.

Quite recently, the third annual general meeting of the West Indian Sea Island Cotton Association was held in St. Vincent. The meeting which was opened by His Honour the Administrator of St. Vincent, was presided over by the Commissioner of Agriculture, the Assistant Commissioner attending as Secretary. Antigua, Barbados, Montserrat, Nevis, St. Kitts and St. Vincent were all represented. The general work and activities of the Association during 1935 were reviewed by the President who also presented reports on the work of the Advisory Committee in England and on the research work of the Wool Industries Research Association in connection with mixed rovings of Sea Island cotton and wool.

The attention of the meeting was directed, in the first instance, to the existing position of the industry and in view of the favourable statistics and information which were submitted, especially in regard to prospective demand, a programme of increased production was approved. To prevent the accumulation of unsold stocks in the United Kingdom it was decided that the unrestricted export of cotton lint on consignment was not desirable, and recommended that the Governments of the islands concerned should limit the amount of cotton lint exported on consignment which might remain unsold in England at any one time, a quota being suggested for each island.

Much useful information was exchanged amongst the delegates in regard to the questions of grading and the preparation of a standard bale of cotton for export. It was recommended that the ultimate aim should be a bale of 400 lb. containing about 20 lb. of lint per cubic foot. The Governments of the islands concerned were asked in this connection to introduce legislation to control the type of wrapping material for bales for export.

The need for the regular supply of reliable market information was generally recognised and stressed, and it was decided to ask the Advisory Committee in England to make arrangements, if possible, for the collection and transmittal of the desired information at regular intervals. The suggestion was also put forward to the Committee that an officer be employed to undertake the combined duties of Secretary to the Advisory Committee, of trade mark administration, and of market intelligence officer. Subject to this suggestion being approved financial provision was made in the estimates of expenditure for the employment of such an officer.

The possibility of instituting a system of co-operation for marketing all the Sea Island cotton grown in the British West Indies was examined. Although some delegates saw serious obstacles which, in their opinion, determined the impracticability of carrying out any such scheme it was recommended that the Islands Cotton Growers' Associations should investigate the practicability of putting into effect a scheme of co-operative marketing in their respective islands, with the ultimate object of establishing a single co-operative marketing organisation for the disposal of the cotton produced in all the islands.

Attention was drawn to the needs for establishing an entomological service to study and, if possible, introduce further methods of control for the several cotton pests in the islands. The President was, in this connection, requested to investigate the possibility of establishing such a service and guaranteed financial assistance for a period of three years towards the cost of the service.

Finally, on the suggestion of the St. Vincent Chamber of Agriculture and Commerce, it was agreed that the Governments of all the British West Indian Islands, British Guiana and Bermuda be invited to consider the question of admitting free of duty for a period of three years all goods made from Sea Island cotton and bearing the trade mark of the Association.

At this meeting the draft Memorandum and Articles of Association for the incorporation of the Association were considered, amended and approved. In due course the necessary steps will be taken to incorporate the West Indian Association in Trinidad and the Island Associations in the respective islands. There is no doubt that the Association has made remarkable progress during the past year and that it has contributed in a large measure towards the improved conditions obtaining today in the Sea Island cotton industry. How long this comparative prosperity will last cannot of course be predicted but it would appear that it certainly rests on sound foundations. Referring to the assistance which associations of this kind can render to local governments His Honour the Administrator of St. Vincent stated in his opening address to the delegates " To your Association and others of its kind the peoples and administrations look for the unravelling, knot by knot, of that tangle of economic problems which, in the last analysis, is seen to give rise to the social and spiritual difficulties under which our communities are labouring " and " it is upon your willingness to stand together, your united common-sense, and the work of your Advisory Committee in England that the safety of the Sea Island cotton market depends ".

COCONUT HUSK ASH AS A FERTILIZER.*

THE ash of burnt coconut husks contains 10 to 25 per cent. of available potash. The chemical fertilizer, sulphate of potash, contains about 48 per cent. of available potash. Coconut husk ash therefore may have a manurial value from a quarter to half that of sulphate of potash. The composition of the ash will vary with the conditions under which the husks are grown and the method by which they are burnt. The lower the temperature of firing the richer in potash will the ash be, so that the best method is that of the slow burning heap of husks. The ash must be kept dried when stored as the potash is readily soluble. A disadvantage of coconut ash on heavy clay soil but not on light soils may be that the soda ash which it contains will tend to bind the clay and so impair the tilth. A second disadvantage is that the ash may contain a considerable proportion of chloride or common salt particularly when derived from plants growing close to the sea. Citrus is very susceptible and bananas moderately so to chloride so that coconut ash should not be used for them. Coconuts require the chloride and sugar-cane is unaffected by it. An experiment to determine the loss of ammonia likely to occur if the coconut ash was mixed with fertilizers containing ammonia showed that a mixture containing two parts coconut ash and one part sulphate of ammonia would, if spread on a dry soil, lose 50 per cent. of the ammonia in 5 days and if spread on a wet one, 80 per cent. The latter condition is equivalent to a loss on a ton of sulphate of ammonia of £6 10s. It is recommended that ammonia-containing manures should be applied at least a fortnight before the ash. Fertilizers not containing ammonia may be safely mixed with coconut ash.—(*Imp. Bur. of Fruit Prod. Hort. Abstracts.* Vol. V, No. 1, Abs. 140, p. 52, 1935.)

*Croucher, H. H. and Martinez, R. S., in *Journal of the Jamaica Agricultural Society*, 1934, Vol. XXXVIII, pp. 617-19.

SOME NOTES ON COTTON IN COLOMBIA.*

By S. C. Harland, D.Sc. (Lond.).

Introduction.

In response to an invitation by Sr. Don Pedro Obregon of the Fabrica de Tejidos "Obregon" of Barranquilla, Colombia, and by permission of the Empire Cotton Growing Corporation the writer visited certain cotton growing districts of Colombia during February and March, 1935. Three representative districts were examined in some detail. In two of these, the Atlantic region and the Urometa-Dabeiba district of the Department of Antroquia, cotton is grown on a commercial scale. In the third—the Valle del Cauca on the Pacific side of Colombia, cotton is not grown commercially, but an assemblage of wild and semi-wild cottons exists which is of great interest from the point of view of the cotton breeder.

The Atlantic Region.

This region comprises the stretch of flat country which lies on either side of the lower reaches of the Magdalena river. A considerable amount of cotton, approximately 1,500,000 kg. of lint is produced, mainly by small proprietors who plant cotton with such food crops as cassava (yucca), maize and pigeon peas.

The district is interesting because it is one of the few remaining tracts which grow the Bourbon type of tree cotton (*Gossypium purpurascens* Poir).

In a previous report an account was given of the cotton growing industry of the State of Rio Grande do Norte in North Brazil. The only other two districts known to the writer which grow Bourbon cotton are first the Grenadines of the Windward Islands in the British West Indies, and Haiti. In all these regions a similar system of cultivation is practised. Cotton is grown as a perennial at a spacing which ranges from 5 ft. by 5 ft. (Carriacou) to 8 ft. by 8 ft. (North Brazil). The spacing in the Atlantic region appears to be approximately 6 ft. by 5 ft. The practice of growing cotton as an adjunct to food crops may be taken to be agriculturally sound, as even if a total failure of the cotton crop is experienced the cultivator still has sufficient food for his needs. Cotton under these conditions can thus be regarded chiefly as a catch crop and its needs must necessarily remain agriculturally subordinate to those of the food crops with which it is accompanied.

Under the conditions of the Atlantic region replanting has to be done every third or fourth year. In North Brazil the trees in favourable localities may attain an enormous size and last for 10 to 15 years. In Carriacou the stand is kept up merely by supplying missing holes with seed at the beginning of the rainy season. It is difficult to state the reason why the life of Bourbon in the Atlantic region is so short. It may be that competition with cassava is too severe; it may be a question of termites attacking the roots, or it may be due to the practice of cutting the trees down close to the ground before sufficient food reserves for fresh vegetative growth have been accumulated. The current practice of cutting the trees down before all the bolls have ripened is supposed to induce the bolls to open, but it has the effect of causing the lint to be short and weak. Since all the cotton is consumed by local mills this does not reduce the market value of the lint. The manufacturers however recognise the harm done by this practice and would like to see it stopped.

Type of Cotton.

As stated above the cotton grown is a variety of Bourbon *G. purpurascens* Poir. It presents the following points of interest:—

(1) The ginning percentage is 30 to 32, being higher than any Bourbon previously seen. The new type of Bourbon which is being propagated on a large scale in the Grenadines has a ginning percentage of about 25 and it is clear that the Colombian type will be extremely useful to cross with the West Indian in order to raise the ginning percentage of the latter.

(2) The seeds are usually of the tufted type, *i.e.*, black with a small greenish tuft. As in Brazil and the Grenadines a certain proportion of the plants produce naked seeds, a character which should be eliminated by selection.

(3) The length of the lint varies from ½ in. to 1¾ ins. in individual plants. The quality of the lint from long linted plants is extremely good and resembles Pima or Sakel Egyptian in quality. Selection of such long linted plants would undoubtedly result in the isolation of a good type of cotton possibly better than the new Antilles cotton recently developed in the Grenadines. For her own internal requirements however, Colombia needs a cotton of 1 in. to 1⅛ ins. staple length, and the presence of long linted types is disadvantageous from the manufacturer's standpoint.

(4) The colour of the lint varies from medium brown to white. A correlation was noticed between the colour of the lint and the length, the brown linted types being definitely shorter.

A number of representative types of cotton were collected and will be further studied in Trinidad in 1935-36.

Insect Pests.

At the time of inspection the cotton season was coming to an end. A number of observations was however made on the insect pests of cotton in this region.

* Based on "Report on a visit to the Cotton Districts of Colombia" made to the Empire Cotton Growing Corporation to whom our acknowledgments are due for permission to publish.

THE COTTON STAINER (*Dysdercus mimus* SAY).

In common with other tropical cotton growing countries, the Cotton Stainer is a major pest in this region. Examination of green bolls showed the internal boll disease to be highly prevalent in some districts, while other districts showed only a slight percentage of staining. Examination of the commercial cotton in storehouses sometimes showed as high as 50 per cent. of stained lint. The chief alternative hosts of the Cotton Stainer, viz.:—Silk Cotton *Eriodendron* sp. as well as an undeterminated tree known as "Ceiba", appeared to be rather abundant, together with other malvaceous plants chiefly *Sida* spp. capable of acting as food plants. In some districts *Sida* was the most common weed along the road-side and in waste places. Stainers were found breeding on *Sida* in small numbers. *Thespesia populnea* (John Bull Tree) one of the worst alternative stainer plants in the West Indies was also fairly common. It is probable that as in the West Indies the destruction of Silk Cotton trees would be advantageous.

A number of stainers was collected in order to see whether any parasites existed, but none were found.

THE TRINIDAD BOLLWORM (*Sacadodes pyralis* DYER).

This pest caused tremendous damage to the crop during the current season and is said to cause great damage every year. The life history was studied by Withycombe in Trinidad (*Tropical Agriculture*, Vol. II, No. 12, 1935, pp. 286-7) where it occurs as a minor pest. Taxonomically it is said to be closely related to the Sudan Bollworm of Africa and is thus of considerable interest as being a possible host of parasites which might when introduced into Africa exercise an effective control over the Sudan Bollworm. With this point in mind an extensive search was made for parasites. Cocoons of a larval parasite were found to be relatively abundant and some were sent to Trinidad by air mail. They were examined by Dr. Myers who reported that the sample contained one primary parasite and three hyperparasites. Specimens of these have been sent to England for determination.

This insect has been recorded also from Venezuela and Argentine and must be considered as a major pest of cotton in Colombia.

BLISTER-MITE (*Eriophyes* SP.)

Many plants throughout the Atlantic region were attacked by a type of Blister-mite differing considerably from the West Indian form. The latter affects principally the leaves and growing point and produces very little effect on the mature stem. It does not attack Bourbon cotton at all. The Colombian Blister-mite does attack Bourbon cotton quite considerably though some plants appear to be quite immune. The characteristic galls are thickly clustered on the stems, the leaves being less attacked. Trial plots of Upland cottons were so badly attacked as to reduce the yield almost to vanishing point. This illustrates the point of view previously expressed on many occasions by the writer that before cotton growing is embarked upon in a new country it is necessary to have a complete survey of the pests and diseases attacking native cotton since such pests might prove uncontrollalle in larger areas, particularly on exotic cottons.

It is probable that the Colombian Blister-mite is a different species of Eriophyes although microscopic examination showed no marked gross differences from the West Indian form. The Colombian form was noted also on wild Bourbon near La Guayra (Venezuela).

THE COTTON WORM, *Alabama argillaceae*.

Severe attacks of Cotton Worm occur every year in Colombia. Control by the application of arsenicals is very little practised and much damage to the crop results. As the type of cotton grown in the district is perennial the damage is naturally less than would have been experienced with a cotton of the Upland type, since after an attack a fresh crop of leaves would soon make its appearance.

OTHER INSECT PESTS.

Termites appear to cause some damage to old plants. *Heliothis obseleta* was not observed to attack cotton and it is probable that it does not do so in this region. Scale insects were noted but were not doing any appreciable damage.

DISEASES.

As the region is one of rather low rainfall with the Acacia association characteristic of an ecologically good cotton growing region, there is little sign of disease. Blackarm was not noted or any of the commoner boll rots of the West Indies.

FUTURE PROSPECTS OF THE COTTON INDUSTRY OF THE ATLANTIC REGION.

From what has been said above it will be gathered that the factors adverse to the development of cotton growing on a big scale in this region are almost entirely entomological. As in other cotton growing regions of the Tropics, there is a disastrous combination of Bollworm and Stainer and it is clear that extensive studies of these two insects are required. Since the Atlantic Region constitutes a definite ecological province it is at least possible that the introduction of parasites for both *Sacadodes* and *Dysdercus* might go far towards providing a solution. In the absence of control of these insects the region could never be classed as a first class one for cotton growing although with suitable varieties and good agriculture it might quite easily produce up to half a million bales per annum. It may be especially noted that the Pink Bollworm has so far not made its appearance in the country, although it was found near Porto Cabello (Venezuela).

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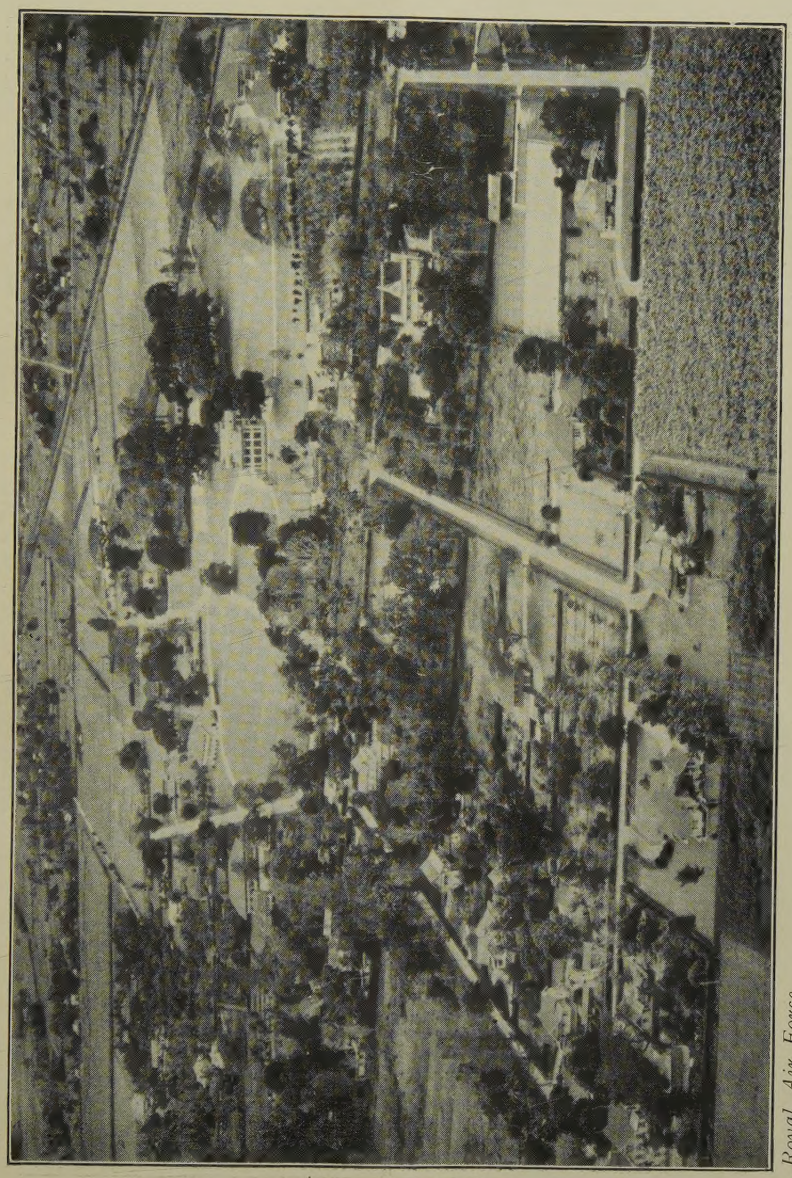

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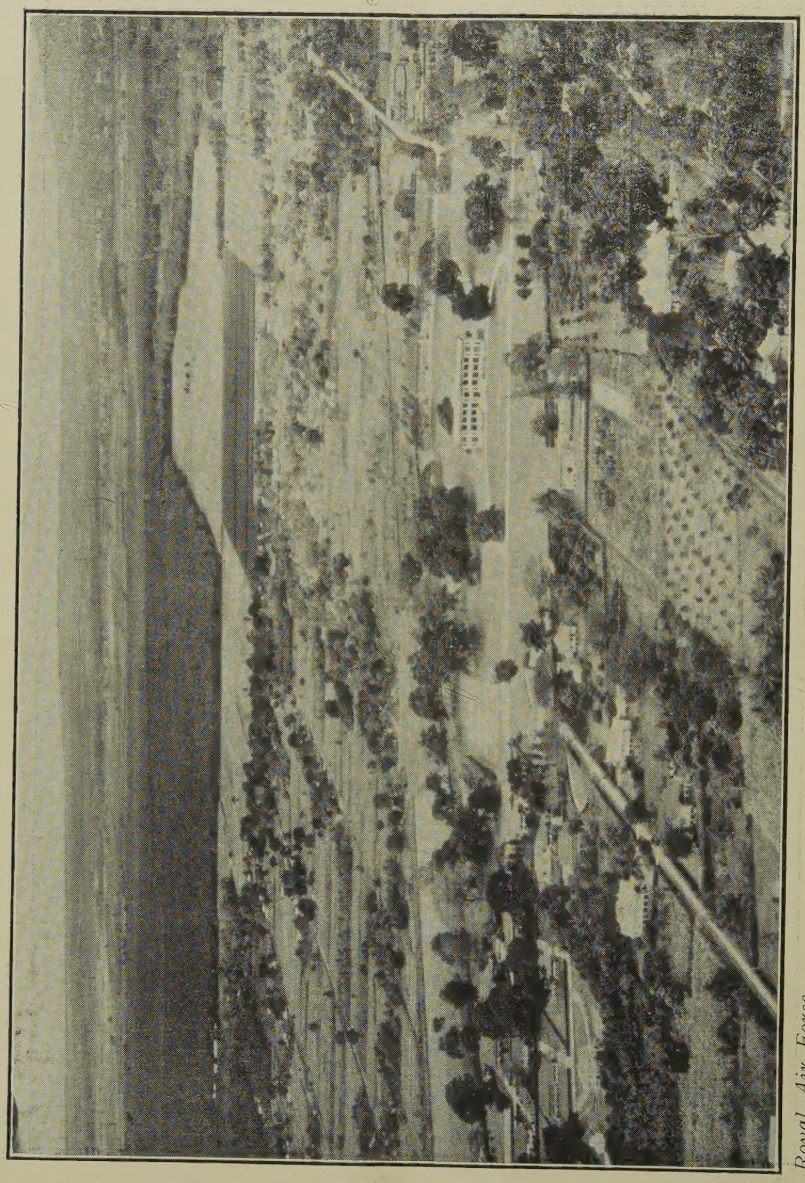

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The Urometa-Dabeiba District of Antioquia.

On the invitation of the Cotton Association of Medellin a visit was paid to the cotton growing district which supplies the Medellin factories with raw cotton. The Urometa-Dabeiba district is situated some 200 miles from Medellin and the new road to the Gulf of Panama is expected to pass through the region. At present it is possible to go by car about 200 miles, thence by mule. Accompanied by a representative of the Association the writer proceeded to Canas Gordas by car and subsequently 22 miles by mule to Urometa. In this district considerable quantities of cotton are now grown, the present crop amounting to about four hundred thousand kilos. An extensive inspection of the district around Urometa was made.

TYPE OF COTTON.

The cotton grown is a variety of *G. barbadense* closely similar in characters to the Ishan cotton of Nigeria. Before cotton growing was started it was said to be grown by the Indians in the locality for hand woven fabrics. The local name is "Vergara". It presents the following points of interest:—

(1) The ginning percentage is extraordinarily high, being over 40 per cent.

(2) The lint length is about 1 in., the fibres being very coarse and of a cream colour.

(3) The seeds are either completely fuzzy or of the Egyptian tufted type.

(4) The boll is usually 3-locked and contains about 12 seeds in each lock as against 6-7 in Upland or Egyptian. The boll weight of the "Vergara" cotton is thus about twice as high as any *barbadense* type before encountered, and if this character could be transferred to Egyptian or Upland as seems possible, the resulting type would be of considerable commercial importance. There is no doubt that the present Egyptian boll is far too small.

(5) The cotton seems to be of a perennial type but is not as vigorous as most of the perennial types of *barbadense*.

AGRICULTURE.

The "Vergara" cotton is grown in the usual peasant style, that is in a mixed cultivation of corn, cassava and leguminous plants. This type of agriculture seems to be universal in all tropical regions where perennial cottons are grown and appears to possess considerable advantages where the cotton is a secondary consideration.

INSECT PESTS.

(1) COTTON LEAF BLISTER-MITE (*Eriophyes gossypii*, BANKS.).

All the cotton was severely attacked by the above pest or by a closely allied species. The resulting diseased appearance goes under the local name of "Verruga". The yield was considerably curtailed owing to the complete disorganisation and crippling of all the growing points. In consequence of Blister-mite attack, replanting has to be done every year. The mere substitution of an immune Bourbon from the West Indies or from the Atlantic region would effectively control the disease. The enforcement of a rigid close season would have a similar effect, but would be difficult to enforce in a peasantry completely ignorant of modern agricultural methods—a population which is apparently much behind the West Indian Negro in agricultural outlook.

(2) THE COTTON STAINER (*Dysdercus ruficollis*).

Severe stainer damage by the above species of Dysdercus was widespread and had caused great loss of crop. At the time of inspection all bolls were attacked by Internal Boll disease and it was evident from hand inspection of the seed cotton in the ginnery that a large proportion of the cotton had been damaged. Any extension of the cotton growing area in this district would doubtless lead to even greater damage by stainers. Silk Cotton trees were quite common and the whole district was extraordinarily rich in malvaceous plants upon which stainers were often very numerous. Species of *Sida* carrying abundant stainers were present over most of the 200 miles of road from Medellin to Canas Gordas and occurred at all altitudes from 6,000 feet downwards.

From existing knowledge of the enormous potentialities for damage of cotton stainers under such conditions as this, it may be hazarded that the whole of this very big district can never be more than second class as regards cotton growing, although considerable extension of peasant cultivation is possible.

DISEASES.

No fungus or bacterial disease was seen, other than Internal Boll disease and it is highly probable that Blackarm has not yet been introduced into this district of Colombia.

Valle Del Cauca.

From Medellin the writer travelled by plane to the town of Cali which is situated in the famous Valle del Cauca. This is an almost flat plain about 100 miles long by 20 miles broad through which flows the river Cauca. This valley is about 3,000 feet above sea level and the soil is very deep and extraordinarily rich. The principal crops are sugar cane, rice, cacao, coffee and bananas. Sugar cane is said to be reaped every month of the year and such is the fertility of the soil that 75 to 80 tons of cane per acre can be obtained without the use of manures. Rice is extensively grown and as many as 15 crops of rice have been obtained from fields without replanting. The value of the region for cotton growing is difficult to assess. A field of cotton was seen at the Government Experiment Station at Palmyra. This was an Upland variety of some kind and it was severely attacked by stainers (*Dysdercus ruficollis*), Blister-mite, Bollworm (*Sacadodes pyralis*) and jassids. A combination of all these four pests would seem to provide an insuperable obstacle to the development of a cotton growing industry.

A large number of wild or semi-wild cottons were scattered throughout the district in peasant gardens. These consisted mainly of *barbadense* types with a few examples of *purpurascens*. The *barbadense* cottons were of extraordinary interest. Every plant carried a different combination of characters and a large number of combinations of dominant genes were met with, previously quite unknown in this species. For example one type possessed the characters red leaf, hairy plant body, khaki lint and fuzzy seed. According to the generally accepted theory of Vavilov, the centre of origin of a species is characterised by a concentration of dominant genes. The writer has for some time held the opinion that the original centre of origin of the species *Gossypium barbadense*, including Egyptian, Sea Island, Tanguis, Ishan Kidney, &c., was on the Pacific side of the Andes, probably between Colombia and Peru. From the extraordinary richness of forms in the Valle del Cauca it may be suggested that it is this region or somewhere not very far from it which is the original home of *G. barbadense*. Owing to lack of time it was not possible to collect more than a few examples and it would be of great advantage to revisit the whole of the region through Ecuador to Peru to study the types of *barbadense*. It is possible that some forms would be found to occur immune to Blackarm since in other plants Vavilov has found that at the centre of origin disease resistant forms tend to occur.

About 50 miles south of Cali a primitive type of *purpurascens* with mahogany coloured lint was collected.

"AERIAL WELLS" AND SOIL MOISTURE.

Two secondary sources of soil moisture—mist and dew—are well recognised especially where the rainfall is low. Yet a third and less obvious source is the so-called "dehydration of air" by soil and other materials. Some suggestions for the possible utilization of this phenomenon are contained in an article by M. Aragou (1) in the Bulletin of the International Institute of Agriculture. The phenomenon has also been discussed recently by T. Eden (2) and L. Chaptal (3). A striking example of what this process can accomplish is found in ancient times. About 500 B.C. there were at the town of Theodosia on the Black Sea 13 enormous pyramids of crushed limestone which by collecting atmospheric moisture furnished the town and its garden under excessively dry climatic conditions with 7,000,000 litres (154,000 gallons) of water per day. An "aerial well" on the same principle is functioning at the present day at Traus (Department of Var., France).

Evidence of this phenomenon occurs in Nature: outcrop springs in certain rocky deposits, composed of boulders covered with vegetation, derive their moisture chiefly by atmospheric dehydration. Practical use of the moisture collecting property of stones is also made in vine and olive culture. Olives are protected by building little stone walls around them, whilst it is well known that vineyards on rocky slopes suffer drought less than the average.

Some very interesting experiments have been carried out by L. Chaptal at Montpellier. He constructed an aerial well by piling calcareous (non-marly) stones 5 to 10 cms. in diameter to a height of 2.5 m. into a rectangular pyramid over a 3 m. square concrete catchment platform. The stones were covered with a layer of concrete with holes top and bottom to permit the circulation of air. A sunken reservoir was connected to the concrete platform. Making allowance for the moisture collected in the form of dew, it was found that this aerial well collected about 19 gallons of water from April to September in 1930, and in the less favourable year following, about nine gallons; the maximum yield for one day was just over half a gallon. An interesting point is the fact that the temperature of the stones was invariably several degrees higher than that of the outside air so that it was quite exceptional to find dew formed in the well during the night. Also, there was no relation between the moisture collected by the well and the deposition of dew around and outside it.

That a similar process takes place to a lesser degree in the soil is indicated by the observation made at Montpellier that during three months of dry weather the top layers of the soil received moisture by dehydration of the air equivalent to 0.6 mm. of rain per day. This occurred when the air temperature was too high for dew to form. Similarly, recent experiments made by Ramdass and Katti at Poona show that an exposed soil invariably contains more moisture at sunrise than at sunset. The gain runs in the neighbourhood of 2 to 3 per cent.

In places subject to periodic drought, soil moisture conservation is mainly determined by the type as well as the time of cultivation of the soil. It is clear that under some climatic conditions loosening the soil may increase soil moisture by stimulating dehydration of the air. The question of the good or harm of mulching and surface cultivation again depends on the moisture content of the soil at any given time in relation to the oncoming changes in climatic conditions. As Eden points out, the contribution of "dehydration" moisture to the soil is not permanent and the moisture will have, in some circumstances, no time to diffuse lower into the soil before it is evaporated by solar radiation. Such secondary sources of moisture must therefore be deposited in close contact with plant roots for immediate use.

It does not seem as if soil physicists have paid full attention to this dehydration property of soil. A closer study of it might have a profound influence on cultivation practices in dry-farming regions.

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(1) Aragou, M.—*Internat. Rev. Agric. Mo. Bull. Agr. Sci. Pract.* Rome, 1935, No. 4.
(2) Eden, T.—*Tea Quarterly*, 8, 1935, p. 31.
(3) Chaptal, L.—*Trans. 1st. Comm. Internat. Soc. Soil Sci.* 1934, pp. 205-207.

(Imperial Bureau of Soil Science, *Monthly Letter* No. 46, 1935).

A VARIETY TEST IN SUGAR CANE.

By R. Cecil Wood, M.A.

An experiment was started in 1930 to compare primarily a number of thin canes as to their suitability for Trinidad conditions. Four crops have now been taken, a plant crop and three ratoons, and the plots have continued to bear so well that they are being continued to a fifth harvest. The present note brings the results up to date, in view of the interest which the experiment possesses for the cane-growers of the island.

Table I.

Season 1934-35. Third ratoon crop.

Variety.	Yield of Cane.		Yield of Sugar 96 %.	
	Tons per acre.	Per cent. Uba.	Tons per acre.	Per cent. Uba.
P.O.J. 2878	29.71	127	3.40	178
Co. 213 ..	22.62	96	2.50	131
P.O.J. 36 ..	21.17	90	2.24	117
M. 36 (2 plots only) ..	*21.61*	*90*	*2.26*	*118*
P.O.J. 213 ..	16.82	72	2.10	110
Uba ..	**23.48**	**100**	**1.91**	**100**
Co. 281 (2 plots only)	*15.06*	*64*	*1.89*	*98*
P.O.J. 234 ..	13.86	59	1.62	85
P.O.J. 826 ..	7.41	32	.91	48

Significant differences: cane 4.4 tons
sugar .5 tons per acre.

The figures for the previous three crops have been published in this Journal: IX. 290, X. 188, and XI. 201.

The sugar yields were obtained by putting the total produce of each plot through the College mill. The College Sugar Technology Department kindly undertook the sampling and analysis of the juice.

The results of the four crops are summarised in Table II, arranged in order of sugar yield, which will enable conclusions to be readily drawn from them.

Table III shows the ratio of cane to sugar, and indicates the sugar content of the different varieties.

Table III.

Tons cane to 1 ton sugar.

Variety.	Plant.	1st rat.	2nd rat.	3rd rat.	Mean.
P.O.J. 2878	12.9	9.8	9.0	8.7	10.1
Co. 213 ..	15.0	12.1	9.9	9.1	11.5
P.O.J. 36 ..	13.8	11.1	9.1	9.4	10.8
M. 36 ..	*14.4*	*12.3*	*10.4*	*9.5*	*11.6*
P.O.J. 213 ..	11.7	9.6	7.7	8.0	9.0
Uba ..	**13.2**	**11.8**	**9.9**	**11.9**	**11.7**
Co. 281 ..	*10.9*	*9.9*	*15.4*	*8.0*	*11.5*
P.O.J. 234 ..	11.3	9.5	8.5	8.4	9.4
P.O.J. 826 ..	12.9	8.7	8.6	8.1	9.5

Table II.

Total yield for four seasons.

Variety.	Tons cane per acre.					Tons sugar per acre.				
	Plant.	1st rat.	2nd rat.	3rd rat.	Total.	Plant.	1st rat.	2nd rat.	3rd rat.	Total.
P.O.J. 2878 ..	63	30	34	30	157	4.87	3.06	3.79	3.40	15.12
Co. 213 ..	57	34	26	23	140	3.80	2.82	2.63	2.50	11.75
P.O.J. 36 ..	33	26	22	21	102	3.40	2.80	2.63	2.24	11.07
M. 36 ..	*48*	*32*	*25*	*22*	*127*	*3.32*	*2.60*	*2.40*	*2.26*	*10.58*
P.O.J. 213 ..	23	20	17	17	77	3.16	2.72	2.46	2.10	10.44
Uba ..	**37**	**26**	**19**	**23**	**105**	**2.50**	**2.21**	**2.38**	**1.91**	**9.00**
Co. 281 ..	*47*	*31*	*24*	*15*	*117*	*2.75*	*2.33*	*1.30*	*1.89*	*8.27*
P.O.J. 234 ..	30	23	20	14	87	2.03	2.18	2.01	1.62	7.84
P.O.J. 826 ..	33	20	13	7	73	2.55	2.30	1.51	.91	7.27

Significant differences on totals:—cane 13 tons; sugar 1.56 tons.

The commonest thin cane of Trinidad is Uba, which is grown to quite a considerable extent in some areas, and it is accordingly taken as the standard of comparison. Table IV shows the total weights of cane and sugar produced to date, expressed as a percentage of Uba.

Table IV.

Variety.	Total cane produced in 4 years.		Total sugar in 4 years.	
	Tons per acre.	Per cent. Uba.	Tons per acre.	Per cent. Uba.
P.O.J. 2878 ..	157	150	15.12	168
Co. 213 ..	140	133	11.75	131
P.O.J. 36 ..	102	97	11.07	123
M. 36 ..	*127*	*121*	*10.58*	*117*
P.O.J. 213 ..	77	73	10.44	116
Uba ..	**105**	**100**	**9.00**	**100**
Co. 281 ..	*117*	*111*	*8.27*	*92*
P.O.J. 234 ..	87	83	7.84	87
P.O.J. 826 ..	73	70	7.27	81

Significant differences: cane 13 tons
sugar 1.56 tons.

The canes have received manure as follows:—
(All figures per acre).

1930-31—7 tons limestone in April. A very heavy crop of sunn hemp was ploughed in in August, and in September 12 tons of pen manure. Canes planted in October.
1931-32—
1932-33—1 cwt. sulphate of Ammonia (approximately).
1933-34—1 cwt. Sulphate of Ammonia.
1934-35—Amm. Sulphate 3 cwts; Muriate Potash 1 cwt.; Superphosphate 1 cwt.
1935-36—Amm. Sulphate 3 cwts.

There is little to be said about the figures, which speak for themselves. P.O.J. 2878 continues to be the best, and by a very large margin. Though it is not a favourite in the mill, owing to its habit of frothing and difficult clarification, it would seem deserving of a more thorough trial than it has yet had. The next group includes Co. 213 and P.O.J. 36 and possibly M. 36, though the data about this cane is not sufficient to enable a definite assertion to be made. P.O.J. 36 produces almost the same amount of sugar as Co. 213, with nearly 10 tons an acre less cane each year, implying a considerable saving in cutting and transport and milling charges. P.O.J. 213 is still more remarkable for richness and has the remarkably low average for all the four crops of 9.0 tons of cane to the ton of sugar. All the above canes are definitely superior to Uba. The remaining three are inferior to Uba in the production of sugar, though slightly better in quality, and do not merit discussion.

I wish to acknowledge the assistance given by the Department of Sugar Technology in arranging for the sampling and analysis of the canes, thus enabling the figure for sugar to be quoted.

Post-Graduate Students of the College have been associated with this work: Messrs. Milburn and Coombs in 1932-33, and Mr. Chan Choong in 1935-36.

CHARCOAL MANUFACTURE FROM COCONUT SHELL.*

Charcoal can be obtained from coconut shell heated in a closed space without the presence of air. Large quantities of volatile by-products are produced at the same time, but these require an efficient retort and condensing plant for their recovery. To obtain charcoal only the age-old method of burning in turf or mud-sealed heaps is used in Malaya. The enclosed heap is fired through a central hold previously filled by a stake and when the shells are thoroughly burning the supply of air is cut off, carbonization proceeding without further combustion. Good charcoal is produced by this method which takes about 12 hours. In the morning the pile is watered and allowed to cool off. In Ceylon, where excavation is possible without reaching water, the charcoal is made in covered pits 4 to 6 ft. deep. The fire is started at the botton with a few shells and then built up till it is full and well alight, when it is watered and closed down. Alternatively a hollow bamboo pipe is placed vertically in the centre and the pit filled to ground level with shells, paraffin poured down the pipe and lighted, the flames watered and the pit closed. The specification for charcoal in London is as follows: not more than 15 per cent. volatiles, not more than 10 per cent. moisture. The requirements for size are that not more than 10 per cent. should remain in a mesh with 1 inch holes or more than 5 per cent. pass through a mesh with ¼-inch holes. Good quality charcoal should be uniformly dark and free from inherent dirt due to husk. When dropped on a stone floor the pieces should emit a clear bell-like ring, and the broken edges show a sharp conchoidal fracture. The manufacture of good charcoal requires great skill and experience since even slight misjudgment will spoil the charcoal, either through incomplete combustion or overburning. In practice the yield of shell charcoal is 25 per cent. or less of the weight of the coconut shell. In Malaya the cost of production for export including selling charges, insurance, &c., is about £6 per ton including freight. Prices offered by European buyers in 1931 were between £10 and £11 per ton, but a recent quotation was as low as £7 per ton delivered.—(*Horticultural Abstracts*, Vol. V, No. 2, Abs. 320, p. 118, 1935.)

* By F. C. Cooke in *Malayan Agric. Jr.*, Vol. XXIII, pp. 172–4.

THE INCIDENCE OF THE LARGE MOTH BORER, *CASTNIA LICUS*,* IN WILD PLANTS IN TRINIDAD.

By D. Vesey-FitzGerald.

An extensive but unsuccessful search for a parasite of *Castnia licus* in Trinidad at the end of 1933 and early in 1934 has added greatly to our knowledge of the status of this moth in wild plants.

Ballou (1912) states that the primitive hosts of *Castnia licus* are plants belonging to the families Bromeliacae and Orchidacae, but Myers (1931) points out that these records probably refer to another species, there being altogether six members of the genus in Trinidad according to Kaye and Lamont (1927).

Besides damaging cane in Trinidad, British Guiana and Surinam, this insect has occasionally been found to attack coconuts, Urich (1915), bananas, Potter (1892), and at times to do considerable damage to plantains in British Guiana, Myers (1931).

Myers (1932) records the discovery of *Castnia licus* boring the Musaceous plant *Heliconia bihai* in the north-west district of British Guiana in 1930, and closely following upon this he discovered the parasite *Zenillia palpalis* attacking the caterpillar in the same plant. More recently the author found larvae which were provisionally determined as *Castnia licus* feeding in *Renealmia* sp. near the mouth of the Essequibo river. The insect was sparingly parasitised by a dipterous larva, but as no adults were reared the species remains undetermined.

Though the various species of *Castnia* have a wide range of food plants and *Castnia licus* in particular has been recorded from palms, Palmae, and sugar-cane, Graminae, it seems now fairly certain that plants belonging to the families Musaceae and Scitaminae are the primitive hosts. As several plants in these families are important crop plants, *i.e.*, bananas, ginger and West Indian arrowroot or ornamentals such as the various species of *Canna*, there is always the risk that *Castnia licus* might be accidentally introduced to some place and subsequently become established on cane. In this connection it is worth noting that experiments have shown that larvae found in the wild plants considered can be transferred to cane, and *vice versa*, without any harmful effects. A careful search throughout Trinidad has revealed the fact that *Castnia* attacks host plants belonging to a certain stage in forest regeneration without showing preference for any particular plant association. There is, however, a tendency for the incidence to be higher in areas of light sandy soils.

The hosts belonging to the family Musaceae are the four species of *Heliconia* found in Trinidad. *H. pulverulenta* is a plant belonging to established forest or advanced second growth forest, being found on the sides of steep ravines, and the edges of streams. This species is not commonly bored by *Castnia*. The two common species of "Balisier," *H. bihai* and *H. humilis*, typical plants of unstable communities, such as early second growth, cacao plantations or abandoned cultivations are the most frequent host plants. These plants are not tolerant of very heavy shade which is also avoided by the adult moth, and this is probably the reason why these species are more frequently attacked than *H. pulverulenta*. The last member of the genus is "Wild Ginger," *H. psittacorum* a plant which covers considerable areas of wet savannah, probably its primitive habitat, as well as colonising the floor of open second growth forest and coconut plantations. The *Castnia* follows this host plant throughout its range of habitats, again illustrating that this insect is more attached to its host than to a plant association.

The closely related family Scitaminae includes a very favourite host plant, namely *Renealmia bracteosa*, known as "Mardi Gras" in Trinidad. This is a plant of poor light soil, growing in sheltered clearings or tolerating the light shade of second growth forest. The incidence in this host is sometimes very high. Two other genera in this family have also yielded *Castnia*, but the occurrence can only be regarded as exceptional. These are *Costus* sp., a plant of stream sides and *Ishnosiphon arouma*, a plant of the shady floor of established forest. It is significant that the other genera of the family which are also more characteristic of the shady floor of established forest are not favourite hosts of *Castnia*.

An examination of the above records shows *Castnia* to be attached to plants belonging to unstable communities under conditions of only moderate shade, though extending into more stable plant associations in the absence of shade. These facts may supply the clue to *Castnia* establishing itself on cane, since this is in effect an unstaple plant community growing under conditions of moderate shade. That *Castnia* has on other occasions been found to show a predilection for Graminaceous and even Cyperaceous hosts has been recorded by Myers (1932).

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* I have to thank Mr. H. Stringer of the British Museum for informing me that the Trinidad sub-species is *Castnia licus insularis*, Holb. For synonyms *see* Kaye & Lamont (1927), p. 121.

INVESTIGATIONS ON SUGAR-CANE AND SUGAR-CANE SOILS IN ANTIGUA.

I.—PRELIMINARY RESULTS OF THE NEW EXPERIMENTAL SCHEME.—Continued.

BY

P. E. Turner, C. F. Charter and F. H. S. Warneford.

Manuring.

Some of the most important preliminary results of the experimental scheme have been obtained from the manurial experiments.

Optimum Size of Dressing of Pen Manure (IVa).

It is customary in Antigua to apply to the soil very heavy dressings of pen manure which may be as large as 40 tons to the acre. If supplies are not available for the whole area which is to be replanted, manure may be purchased from the villages (1). As it is questionable whether it pays to apply pen manure on so generous a scale, and thus to create a need for village manure, an experiment has been laid down to measure the effect of size of dressing of pen manure on yield. The yield data obtained for the plant cane crop in this experiment are recorded in Table IX. They are means for 12 replicates of the individual treatments.

Table IX.—Effect of size of dressing of pen manure on yield of plant canes.

Soil type : Calcareous marl, deep phase (1b).
Total rainfall (14½ months) : 35 inches.
Variety : Ba. 11569.
Estate : Gaynors. *Layout :* Latin squares.
Planted : 8/2/34. *Manured :* 5/7/34.
Reaped : 16/4/35.

Pen manure per acre.	Yield of plant canes per acre.	Gain in yield.
Nil	26.56	—
12 tons ..	32.65	6.09
24 tons ..	34.62	8.06

The pen manure used in this experiment was of excellent quality and far superior to the average product of Antigua, Trinidad, or St. Kitts. It consisted very largely of animal droppings. It was applied in the planting furrows between the stools of cane.

The gain in yield due to pen manure is statistically significant and might be due to chance far less than once in 100 times. A curve of diminishing returns is obtained if yield of cane is plotted against size of dressing of pen manure. The rate of gain in yield falls off rapidly when the dressing exceeds 12 tons to the acre. As far as the plant cane crop is concerned it would appear preferable to divide the supply of pen manure over a large acreage, rather than to manure a small acreage very heavily. Corresponding experiments in Trinidad have given rise to a similar conclusion (7).

It is of interest that the dressings of pen manure were not applied to the plots until July, *i.e.*, until the dry season was over. The gains in yield therefore cannot be attributed to additional conservation of moisture in the soil by the pen manure during the dry season.

A dressing of sulphate of ammonia was applied to one series of plots in this experiment, but no gain in yield resulted from the use of this manure. The effect of sulphate of ammonia on yield of cane under Antiguan conditions is discussed later in this paper.

The topsoil of the experimental area contains 49.6 per cent. of calcium carbonate.

Optimum Size of Dressing of Filter-Press Mud. Filter-Press Mud in Comparison with Pen Manure (IVd).

Filter-press mud, which contains impurities separated from the raw juice of sugar-cane during the process of clarification in the factory, has considerable value in the field. It is used in other countries as a manure for plant canes growing under difficult conditions (*e.g.*, canes planted in the dry season) and for ratoons which have been damaged by fire or in other ways. Some authorities believe that filter-press mud stimulates healthy root growth when root diseases are prevalent. On these grounds it has been suggested that more general use could be made in Antigua of this waste product of the factory, and that it could be used with advantage to replace expensive village manure, at least in part (1).

It is not generally realised that in certain respects filter-press mud is a more concentrated and efficient manure than pen manure, and that weight for weight it can give more beneficial results than pen manure. An experiment has been included in the general scheme to obtain a measure of the optimum size of dressing of filter-press mud under conditions which obtain in Antigua. A dressing of pen manure was applied to one series of plots in this experiment to compare the value of filter-press mud with pen manure. The yield data for the plant canes are set out in Table X.

Table X.—Effect of size of dressing of filter-press mud on yield of plant canes. Filter-press mud *versus* pen manure.

Soil type : Calcareous marl, deep phase (1b).
Total rainfall (13 months) : 41 inches.
Variety : Ba. 11569.
Estate : Yeamans. *Layout :* Two 5×5 Latin squares.
Planted : 2/3/34 *Manured :* 10/7/34.
Reaped : 5/4/35.

Manurial treatment per acre.	Yield of plant canes per acre.	Gain in yield.
Nil	31.76	—
3 tons filter-press mud ..	35.73	3.97
6 tons filter-press mud ..	36.33	4.57
9 tons filter-press mud ..	37.12	5.36
10 tons pen manure ..	35.57	3.81

The filter-press mud and pen manure were not applied to the experimental area until July. Of the total rainfall of 41 inches only five inches fell before the dressings were made.

Much of the mud was applied in the form of hard, dry lumps. It was placed in the planting furrows, between the stools but some distance from them. An examination of the experimental plots during the height of the wet season (some four months after the addition of the mud to the soil) showed that much of the dressing still remained unchanged in its original aggregate form. In view of the physical nature of the dressing, and of the time and method of its application, it is unlikely that the mud could have appreciably aided in conserving soil moisture during any period of the growth of the plant canes.

The pen manure used in the experiment was average in quality, *i.e.*, it consisted largely of undecomposed vegetable matter thinly covered with a layer of animal residues. The pen manure was applied to the soil in the same manner as the filter-press mud.

The gains in yield due to filter-press mud and pen manure might be due to chance less than once in 100 times.

Yield of plant canes is plotted against size of dressing of filter-press mud in Figure 1. A curve of diminishing returns is obtained. The rate of gain in yield falls off rapidly when the dressing of mud exceeds three tons to the acre. As with pen manure, maximum benefit appears to be derived by dividing the supply of mud over a large area rather than by heavily manuring a small area.

The data set out in Table X appear to be the first in the literature which provide a critical measure of the effect of size of dressing of filter-press mud on yield of cane.

It is evident from this table that a dressing to the acre of three tons of filter-press mud can lead to a gain in yield of plant canes as large as that which results from ten tons of pen manure. It is therefore wasteful to apply filter-press mud to the soil at as heavy a rate as pen manure.

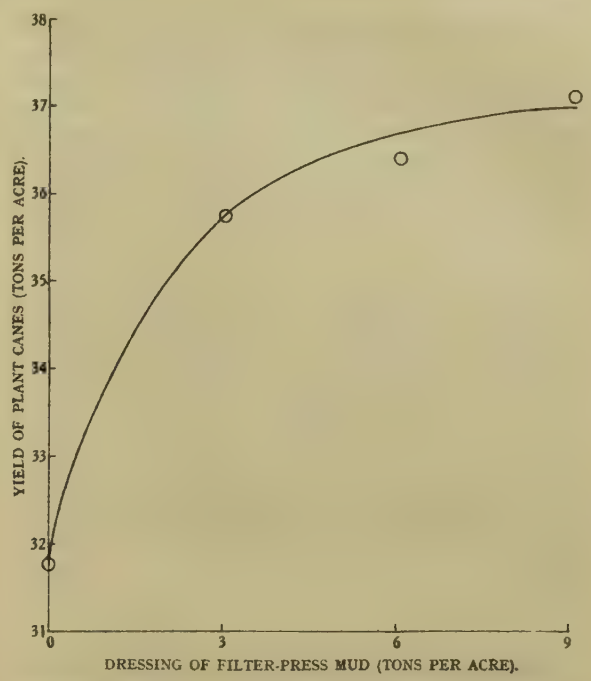

FIGURE 1.—EFFECT OF SIZE OF DRESSING OF FILTER-PRESS MUD ON YIELD OF PLANT CANES.

The gain in yield of 3.81 tons to the acre of plant canes due to ten tons of pen manure of average quality is small in comparison with that recorded in Table IX for pen manure of good quality. It is in close agreement, however, with the gain normally obtained from a dressing of ten tons of Trinidad pen manure (8).

In the factory the raw juice is heated to a temperature in excess of its boiling point for a few minutes before the suspended mud is filtered off in the presses. The mud is sterilised by the heating process. In this respect, therefore, it differs fundamentally from pen manure. Nevertheless, ton for ton, the mud can give rise to much greater increments in yield than pen manure.

It is of importance to note that the mud contain comparatively large amounts of nitrogen and of water-soluble phosphate.

The topsoil of the experimental area contains 17.6 per cent. of calcium carbonate.

Sulphate of Ammonia.

In due course it is intended to lay down in Antigua a series of inter-related experiments to determine the optimum treatment with inorganic manures for the various soil types and sub-types. The experiments will have four main aims (1) :

(i) To determine whether sugar cane responds to nitrogen, to phosphate and to potash :

(ii) to find the total dressing of inorganic manure which gives rise to maximum financial gain :

(iii) to find the proportion of nitrogen, phosphate and potash which should be present in the total dressing :

(iv) to find the optimum time of application of the nitrogen, phosphate and potash.

A beginning has been made with this programme of research. A number of experiments have been laid down to determine whether plant canes respond to treatment with sulphate of ammonia and nitrate of soda, and to obtain a measure of the effects on yield of early and late dressings of sulphate of ammonia. Experiments with nitrogen have also been laid down on ratoon canes.

Plant Canes.

At the present time critical information in relation to the response in yield of plant canes to treatment with sulphate of ammonia is available from two experiments, one of which is situated on a highly calcareous area (Table XI) and the other on an area which contains only small quantities of calcium carbonate (Table XII).

Table XI.—Effect of sulphate of ammonia on yield of plant canes on a calcareous soil.

Soil type : Calcareous clay-tuff (2a).
Total rainfall (12¾ months) : 39 inches.
Variety : Ba. 11569.
Estate : Cochranes. *Layout :* One 6×6 Latin square.
Planted : 29/3/34. *Reaped :* 23/4/35.

Sulphate of ammonia per acre.		Yield of plant canes (tons per acre).
Aug. (1934).	Oct. (1934).	
Nil ..	Nil ..	36.70
Nil ..	2 cwts. ..	38.32
2 cwts. ..	2 cwts. ..	37.33

The manurial treatments were repeated twice in each row and each column of the Latin square in this experiment. There were therefore 12 replicates of the three treatments.

The topsoil of the experimental area contains 8.3 per cent. of calcium carbonate. In the presence of this concentration of limestone the dressings of sulphate of ammonia gave rise to increments in yield which are very small and which are not statistically significant.

Table XII.—Effect of sulphate of ammonia on yield of plant canes on a lightly calcareous soil.

Soil type : Lagoon clay (2c).
Total rainfall (14¾ months) : 42 inches.
Variety : Ba. 11569.
Estate : Betty's Hope.
Layout : Seven randomised blocks.
Planted : 22/12/33. *Reaped :* 16/3/35.

Sulphate of ammonia per acre.		Yield (tons per acre).	Gain in yield.
March (1934).	Aug.-Sept. (1934).		
Nil ..	Nil ..	29.40	—
Nil ..	2 cwts. ..	32.42	+3.02
Nil ..	4 cwts. ..	32.31	+2.91
2 cwts. ..	2 cwts. ..	28.78	−0.62
2 cwts. ..	4 cwts. ..	29.90	+0.50

The topsoil of the experimental area contains 1.6 per cent. of calcium carbonate. In the presence of this smaller concentration of limestone, late dressings of sulphate of ammonia, *i.e.*, dressings applied after the dry season, gave rise to a gain in yield of three tons of plant canes to the acre. This increment might be due to chance less than once in 100 times. Under the conditions of the experiment there is nothing to choose between the gain in yield resulting from late dressings of 2 cwts. and of 4 cwts. of sulphate of ammonia.

The inclusion of an earlier, dry-season dressing of 2 cwts. of sulphate of ammonia, in addition to the later, wet-season dressing, caused complete loss of the gain in yield due to the later dressing. A parallel result has been obtained in an experiment on sugar-cane laid down in the low-rainfall area of St. Kitts. This adverse effect of a dry-season dressing on the gain which can be derived from a later, wet-season dressing is under investigation.

Ratoon Canes.

The effects on yield of ratoon canes of size of dressing of sulphate of ammonia on an alkaline but non-calcareous soil, and on a highly calcareous soil, are recorded in Tables XIII and XIV, respectively.

Table XIII.—Effect of size of dressing of sulphate of ammonia on yield of first ratoon canes on a non-calcareous soil.

Soil type : Alluvial (4).
Total rainfall : 38 inches.
Variety : B.H. 10 (12).
Estate : Blubber Valley.
Layout : Two 4×4 Latin squares.
Manured : 15/5/34. *Reaped :* 7/5/35.

Sulphate of ammonia per acre.	Yield of ratoons per acre.	Gain in yield.
Nil	10.33	—
2 cwts.	14.98	4.65
4 cwts.	16.58	6.25
6 cwts.	17.08	6.75

The pH value of the soil of the experimental area is 7.65, as measured by the quinhydrone electrode. The soil contains no free calcium carbonate. Its alkalinity is probably due to the presence of sodium ions in undue quantity (6). The gain in yield due to sulphate of ammonia on this alkaline non-calcareous soil might be due to chance far less than once in 100 times.

Table XIV.—Effect of size of dressing of sulphate of ammonia on yield of first ratoon canes on a highly calcareous soil.

Soil type : Calcareous marl, deep phase (1b).
Total rainfall : 43 inches. *Variety :* B.H. 10 (12).
Estate : Diamond. *Layout :* Four 4 × 4 Latin squares.
Manured : 17/5/34. *Reaped :* 28/4/35.

Sulphate of ammonia per acre.	Yield of ratoons per acre.	Gain in yield.
Nil	14.65	—
2¼ cwts.	16.03	1.38
4½ cwts.	17.76	3.11
6¾ cwts.	18.21	3.56

The soil of the experimental area contains 29.7 per cent. of calcium carbonate. The gains in yield due to sulphate of ammonia, although small, might be due to chance less than once in 100 times.

Discussion.

Dressings of sulphate of ammonia to soil containing 8.3 per cent. of calcium carbonate gave rise to no appreciable gain in yield of plant canes (Table XI). Dressings of this manure to soil containing 1.6 per cent. of calcium carbonate gave rise to a gain in yield of plant canes which might be due to chance less than once in 100 times (Table XII). The variety of cane planted on both experimental areas was Ba. 11569. There was little to choose between the rainfall on the two areas.

A dressing of 2 cwts. to the acre of sulphate of ammonia to the first ratoon canes on the non-calcareous, alluvial soil, of pH value 7.65, led to an increase in yield of 4.65 tons (Table XIII). A dressing of 6¾ cwts. of this manure to first ratoon canes on the marl soil containing 29.7 per cent. of calcium carbonate led to an increase in yield of only 3.56 tons (Table XIV). In both experiments the variety of cane was BH. 10(12) and the average yield was low. Sulphate of ammonia was applied to both areas at practically the same time. The rainfall was somewhat greater on the calcareous than on the non-calcareous area.

The data recorded in Tables XI, XII, XIII and XIV indicate that under Antiguan conditions treatment with sulphate of ammonia can give rise to a significant increment in yield of plant canes with a total rainfall as low as 42 inches, and of ratoon canes with a total rainfall as low as 38 inches. They indicate that sulphate of ammonia can give rise to a paying increment in yield on alkaline soil of pH value 7.65, provided that calcium carbonate is absent from the soil. They further indicate that the presence of calcium carbonate in excess can adversely limit, or even completely remove, the gain in yield which can result from the use of sulphate of ammonia. These indications are in complete agreement with the results obtained from a series of field experiments with sulphate of ammonia on sugar-cane carried out on unlimed, limed and naturally calcareous soils in Trinidad.

The experiments laid down in Trinidad (9) have shown, among other things, that :—

(1) The diminution in the beneficial effect of sulphate of ammonia on yield of sugar-cane is dependent on the concentration of calcium carbonate in the soil, and is most serious at high concentrations of calcium carbonate.

(2) The diminution could be counteracted by a dressing of readily available phosphate on the area under experiment.

(3) In the presence of a great excess of calcium carbonate, a dressing of potash may be necessary to maintain the gain in yield due to sulphate of ammonia at its normal value, especially on potash-deficient soil. This beneficial effect of potash appears to be dependent on the presence of adequate available phosphate.

These conclusions afford an explanation of the gain in yield of plant canes which results from the use of the sterilised waste product, filter-press mud, as manure on soil containing over 17 per cent. of calcium carbonate (Table X). Filter-press mud contains about 1.2 per cent. of nitrogen and about 0.8 per cent. of water-soluble phosphate as P_2O_5. A dressing of three tons of the mud would therefore contain 50 lbs. of water-soluble P_2O_5. According to the Trinidad experiments this amount is more than adequate to counteract the adverse effect of free calcium carbonate on the gain in yield to which the nitrogen of filter-press mud could normally give rise.

Similarly, there is reason to believe that the gain in yield of plant canes, which can result from the use of pen manure on soil containing over 49 per cent. of calcium carbonate (Table IX), is attributable to the nitrogen *and phosphate*, and perhaps also to the potash, which the manure contains, rather than to special properties which it may be considered to possess by virtue of its origin and method of preparation. The phosphate probably enables the nitrogen present in the manure to exert its customary beneficial effect. The potash may aid the phosphate in this respect, especially in the presence of a high concentration of calcium carbonate.

It should be noted that the phosphate present in the pen manure used in the Trinidad experiments did not become available in appreciable extent to the plant cane crop to which the manure was applied. Pen manure, however, is a very variable product (8). Availability of the phosphate which it contains will depend on a number of factors, including the nature of the material used as bedding, the degree of decomposition of the bedding in the pens, and the conditions determining its rate of decomposition after application as manure to the soil.

In one of the ratoon cane experiments, sulphate of ammonia gave a comparatively small but significant gain in yield on soil containing 30 per cent. of calcium carbonate (Table XIV). It is of interest that the area on which this experiment was laid down has in the past been regularly and heavily dressed with pen manure at each replanting.

In the course of time, sufficient readily available phosphate may have accumulated, through decomposition of the pen manure, to overcome, at least in part, the adverse effect of the free calcium carbonate. Decomposing tops, trash and roots, from the previous plant cane crop, also provide a supply of phosphate and potash which may aid in the more effective use of nitrogen by ratoon canes.

The general trend of the evidence which has been accumulated suggests that it may be possible to obtain paying results from dressings of sulphate of ammonia to plant canes and to ratoons on the calcareous soils of Antigua, provided that readily available phosphate, and perhaps potash also, are applied with the nitrogen. This possibility is under practical test in the experimental scheme.

Sulphate of Ammonia *versus* Nitrate of Soda (IVf).

It has been suggested that nitrates might prove a more suitable source of nitrogen than ammonium salts for sugar-cane on Antiguan soils, in that nitrification is said to be tardy in highly alkaline soils and it has never been satisfactorily proved that the ammonium ion as such is directly available to sugar-cane.

As a result of the experimental scheme critical yield data are now available for three experiments with plant canes on calcareous soils, one experiment with ratoon canes on a lightly calcareous soil and one experiment with ratoon canes on a highly calcareous soil, in which direct comparisons have been made of the effects on yield of the manures sulphate of ammonia and nitrate of soda. The yield data are recorded in Tables XV, XVI, XVII, XVIII and XIX.

Table XV.—Comparison of the effects on yield of plant canes of single and double dressings of sulphate of ammonia and nitrate of soda on a light, calcareous marl.

Soil type : Calcareous marl, deep phase (1b).
Total rainfall (15 months) : 49 inches.
Estate : Parham Lodge. *Variety :* Ba. 11569.
Layout : Two 5×5 Latin squares.
Planted : 29/12/33. *Reaped :* 27/3/35.

Size of dressing of nitrogen.	Kind of nitrogen.		Average yield.
	Sulphate of ammonia.	Nitrate of soda.	
Nil ..	27.83		27.83
42 lbs. N ..	26.80	25.85	26.32
84 lbs. N ..	26.74	26.89	26.81

In the Parham Lodge experiment all the manured plots were given a single dressing of nitrogen in the latter half of June. A second dressing was given nine weeks later to the 'double-nitrogen' plots. Neither sulphate of ammonia nor nitrate of soda had a significant effect on yield in this experiment, irrespective of the size of the dressing. The topsoil of the experimental area contains 24 per cent. of calcium carbonate.

Table XVI.—Comparison of the effects on yield of plant canes of single and double dressings of sulphate of ammonia and nitrate of soda on a calcareous soil.

Soil type : Calcareous clay-tuff (2a).
Total rainfall (15½ months) : 46 inches.
Estate : Cassada Garden. *Variety :* B.H. 10 (12).
Layout : Two 5×5 Latin squares.
Planted : 5/1/34. *Reaped :* 16/4/35.

Size of dressing of nitrogen	Kind of nitrogen.		Average yield.
	Sulphate of ammonia.	Nitrate of soda.	
Nil ..	26.62		26.62
42 lbs. N ..	26.52	27.69	27.10
84 lbs. N ..	25.93	26.93	26.43

In the Cassada Garden experiment all the manured plots were given a single dressing of nitrogen in the middle of August, *i.e.*, in the wet season following planting. A second dressing was given six weeks later to the 'double nitrogen' plots. Neither sulphate of ammonia nor nitrate of soda had a significant effect on yield in this experiment, whether applied in single or double doses. The topsoil of the experimental area contains 2.2 per cent. of calcium carbonate.

Table XVII.—Comparison of the effects on yield of plant canes of single and double dressings of sulphate of ammonia and nitrate of soda on a calcareous marl.

Soil type : Calcareous marl (1b).
Total rainfall (13¾ months) : 40 inches (approx.).
Estate : Ffryes. *Variety :* B.H. 10 (12).
Layout : Two 5×5 Latin squares.
Planted : 15/2/34. *Reaped :* 10/4/35.

Size of dressing of nitrogen.	Kind of nitrogen.		Average yield.
	Sulphate of ammonia.	Nitrate of soda.	
Nil ..	21.71		21.71
42 lbs. N ..	22.26	21.20	21.73
84 lbs. N ..	19.87	20.30	20.09

The manures were applied to the Ffryes experiment at the same time as to the Parham Lodge experiment.

The topsoil of the Ffryes experiment contains 16.4 per cent. of calcium carbonate. There is nothing to choose between the effects on yield of sulphate of ammonia and nitrate of soda in this experiment.

The data recorded in Table XVII are of interest in that the average yield on the plots with 84 lbs. of nitrogen is significantly smaller than the yield on the plots without nitrogen and with 42 lbs. of nitrogen. The average fall in yield of 1.63 tons, due to the heavier dressing of nitrogen, might be due to chance less than once in 100 times. A fall

in yield of this nature, when the dressing of nitrogen exceeds a limiting value, appears to be typical of calcareous soils and to distinguish them from non-calcareous soils (9). Such a fall in yield can be counteracted under the conditions which obtain in Trinidad, by a dressing of potash, provided that the soil contains adequate available phosphate.

Table XVIII.—Comparison of the effects of sulphate of ammonia and nitrate of soda on yield of first ratoon canes on a calcareous marl.

Soil type : Calcareous marl, deep phase (1b).
Total rainfall : 50 inches. *Variety :* B. 147.
Estate : Fitches Creek.
Layout : Four 4×4 Latin squares.
Manured : 11/7/34. *Reaped :* 28/5/35.

Manurial treatment per acre.	Yield of cane per acre.	Gain in yield.
Nil	24.54	—
60 lbs. N as S/A ..	26.26	1.72
60 lbs. N as N/S ..	26.29	1.75

In the ratoon experiments at Fitches Creek and La Roches the plots without nitrogen were repeated twice in each row and column in order to increase the accuracy of the comparison 'nitrogen *versus* no nitrogen'.

The soil of the experimental area at Fitches Creek contains 15.3 per cent. of calcium carbonate. The plant cane crop reaped on this area in the previous year had been dressed with pen manure at the rate of 28½ tons to the acre. As in the case of the experiment with ratoon canes on a calcareous marl at Diamond (Table XIV), treatment with nitrogen gave a small but significant increase in yield which might be due to chance less than once in 100 times. There is nothing to choose, however, between the gains in yield due to sulphate of ammonia and nitrate of soda.

It is worthy of note that 50 inches of rain fell on the experimental area during the life of the ratoon crop.

Table XIX.—Comparison of the effects of sulphate of ammonia and nitrate of soda on yield of first ratoon canes on a lightly calcareous clay-tuff.

Soil type : Clay-tuff.
Total rainfall : 39 inches. *Variety :* Ba. 11569.
Estate : La Roches.
Layout : Four 4×4 Latin squares.
Manured : 10/7/34. *Reaped :* 21/5/35.

Manurial treatment per acre.	Yield of cane per acre.	Gain in yield.
Nil	21.03	—
60 lbs. N as S/A ..	28.00	6.97
60 lbs. N as N/S ..	27.28	6.25

The soil of the experimental area at La Roches contains 1.1 per cent. of calcium carbonate. In spite of the low rainfall (39 inches), treatment with nitrogen resulted in large and paying gains in yield, which might be due to chance far less than once in 100 times. There is nothing to choose between the gains in yield due to sulphate of ammonia and nitrate of soda.

Conclusions.

In the absence of excess calcium carbonate, sulphate of ammonia and nitrate of soda give equally large gains in yield of ratoon canes. In the presence of excess calcium carbonate, both sulphate of ammonia and nitrate of soda fail to give gains in yield of plant canes, although both manures can give small gains of ratoon canes. *The nature of the evidence very strongly suggests that the lack of success which attends the use of sulphate of ammonia on highly calcareous soils cannot be ascribed to tardy nitrification of the ammonium ion.*

Response in Yield of Sugar-Cane to Inorganic Nitrogen in Relation to Concentration of Calcium Carbonate in the Soil.

The information obtained from the preliminary series of field experiments in Antigua, in relation to the effect of concentration of calcium carbonate in soil on response in yield of sugar-cane to dressings of nitrogen, is summarised in Table XX.

Table XX.—Response in yield of sugar-cane to inorganic nitrogen in relation to concentration of calcium carbonate in the soil.

Concentration of $CaCO_3$ in topsoil.	Response in yield to inorganic nitrogen.
Plant canes.	
1.6 per cent. ..	Small but significant gain
2.2 do. ..	Nil
8 do. ..	Nil
16 do. ..	Nil
24 do. ..	Nil
Ratoon canes.	
Nil	Large and significant gain
1.1 per cent. ..	Large and significant gain
15 do. ..	Small but significant gain
30 do. ..	Small but significant gain

Under Antiguan conditions it would seem that inorganic nitrogen, when applied alone, gives rise to only small gains in yield of plant canes on soil containing as little as 1.6 per cent. of calcium carbonate. At concentrations of calcium carbonate of 2.2 per cent., or greater, even small gains in yield do not appear to be obtained.

Inorganic nitrogen can give large gains in yield of ratoon canes in the presence of 1.1 per cent. of calcium carbonate. It can continue to give small gains in yield of ratoon canes when the concentration of calcium carbonate rises as high as 30 per cent. The possibility has been mentioned that decomposing cane tops, trash and roots, from the previous crop, provide a supply of phosphate and potash which aid in the more effective use of the added nitrogen by ratoon canes.

It is unlikely that there exists a well-defined limiting value for concentration of calcium carbonate in the soil, above which dressings of nitrogen fail to give an increase in yield. Such a value would probably be dependent on a number of diverse factors, including rainfall and the store of readily available phosphate and potash in the soil.

Mulching with Trash (IIIb).

One of the most important factors limiting yield of cane in Antigua is lack of soil moisture during the periods of intense drought to which the island is subject. Three main methods may be used for conserving soil moisture :—

(1) Constant working of the surface of the soil to form a dust mulch.

(2) Maintenance of the humus content of the soil at a high level by generous applications of pen manure.

(3) Use of trash, waste grass or megasse as a soil cover.

The relative merits of these methods have previously been discussed (1).

There were included in the preliminary scheme two experiments designed to obtain a measure of the effect on yield of plant canes of mulching with trash in the presence and absence of dressings of sulphate of ammonia. The results obtained from one of the experiments are recorded in Table XXI.

Table XXI.—Effect of mulching with trash on yield of plant canes, in presence and absence of sulphate of ammonia.

Soil type : Calcareous marl, shallow phase (1a).
Total rainfall (16½ months) : 50 inches.
Variety : Ba. 11569.
Estate : Blizzards.
Layout : One 6×6 Latin square.
Planted : 12/1/34.
Mulched : 10/1/34. *Reaped* 24/5/35.

Yields of cane in tons per acre.

Sulphate of ammonia (p.a.)	Trash mulch.	No mulch.	Gain due to mulch.
Nil	32.48	29.76	2.72
2 cwts.	36.30	30.16	6.14
4 cwts.	35.36	30.17	5.19
Average gain due to S/A ..	3.35	0.40	—

The topsoil of the experimental area contains 58 per cent. of calcium carbonate. The mulch of trash was applied on the soil surface shortly before planting. The thickness of the mulch was three inches. All manured plots were given 2 cwts. to the acre of sulphate of ammonia in mid-August, *i.e.*, after the dry season. An additional 2 cwts. of sulphate of ammonia were given six weeks later to the 'double-nitrogen' plots.

The results of this experiment are of considerable interest. The average gain in yield due to the mulch might be due to chance far less than once in 100 times. The average gain in yield due to the mulch in the presence of sulphate of ammonia (5.66 tons of cane) is significantly greater than the gain in the absence of sulphate of ammonia (2.72 tons of cane). The dressing of 4 cwts. of sulphate of ammonia gave no greater gain in yield than the dressing of 2 cwts. The average gain of 0.40 tons of cane due to sulphate of ammonia, in the absence of the mulch, is not significant. The gain of 3.35 tons of cane due to sulphate of ammonia, in the presence of the mulch, might be due to chance less than once in 100 times. The interaction of the mulch with the dressing of sulphate of ammonia might be due to chance less than once in 20 times.

The following conclusions of practical importance arise from the data set out in Table XXI.

(1) The trash mulch functioned far more efficiently, *i.e.*, gave a far greater gain in yield, in the presence than in the absence of sulphate of ammonia.

(2) The dressing of sulphate of ammonia gave far more beneficial results in the presence than in the absence of the mulch.

(3) The gain in yield (6.07 tons of cane) due to mulching with trash, together with manuring with sulphate of ammonia, is far greater than the sum of the gains in yield (3.12 tons of cane) obtained when the mulch and the manure were used independently.

The conditions under which beneficial results were obtained from the use of a trash mulch and a dressing of sulphate of ammonia in this experiment are worthy of mention. The soil of the experimental area had been opened up by ploughing. Previous to mulching there had been a period of drought. *At the time of mulching the soil was extremely dry. It certainly contained no excess moisture to conserve. The conditions which obtained were therefore definitely contrary to the success of the experiment from this point of view. It is of importance to note, however, that part of the heavy dressing of trash was rotting at the time of its application. The material undergoing decomposition may have supplied the phosphate and potash necessary to counteract the adverse effect of the high concentration of calcium carbonate in the soil of the experimental area on the gain in yield to which inorganic nitrogen can give rise.*

In this experiment mulching with trash led not only to an increment in yield but also to a reduction in expenditure on weeding. Costings data for the experimental area are recorded in Table XXII.

Table XXII.—Costings data for mulching and weeding.

Operation.		Cost per acre.
Weeding bare plots		$6.21
Mulching with trash	$1.73	
Weeding unmulched plots ..	1.70	
Expenditure on mulched plots ..		3.43
Balance in favour of mulched plots (excluding gain in yield) ..		$2.78

There is a balance in favour of mulching with trash even if account is not taken of the gain in yield obtained. It should be noted that the cost of mulching with trash may rise as high as $2.40 to the acre in estate practice.

The results of the second experiment on mulching with trash, in the presence and absence of sulphate of ammonia are set out in Table XXIII.

Table XXIII.—Effect of mulching with trash on yield of plant canes in presence and absence of sulphate of ammonia.

Soil type : Calcareous clay-tuff (1a).
Total rainfall (13½ months) : 48 inches.
Variety : B.H. 10 (12).
Estate : North Sound.
Layout : 12 randomised blocks.
Planted : 13/2/34.
Mulched : 14/1/34. *Reaped :* 3/4/35.

Yields of cane in tons per acre.

Sulphate of ammonia (p.a.)	Trash mulch.	No mulch.	Loss due to mulch.
Nil	30.91	33.18	2.27
2 cwts.	31.16	32.78	1.62
4 cwts.	31.85	33.20	1.35
Average gain due to S/A ..	0.59	−0.19	—

The topsoil of the experimental area contains 12 per cent. of calcium carbonate. Trash was applied at the rate of 5½ tons to the acre, giving a mulch of three inches thickness. All manured plots were given 2 cwts. to the acre of sulphate of ammonia in mid-June, *i.e.*, when bunching was in progress. An additional 2 cwts. of sulphate of ammonia were given to the 'double-nitrogen' plots eight weeks later, *i.e.*, when 'cane formation' was under way.

On this experimental area, treatment with nitrogen had no significant effect on yield. Mulching with trash led to an average loss in yield of 1.74 tons of cane to the acre, which might be due to chance less than once in 100 times. No interaction took place between the mulch and the dressing of nitrogen.

The mulch was applied at a time when the soil was very moist. Growth measurements on the young plants early in the dry season make it evident that the mulch conserved moisture. Five weeks after planting the number of growing plants, and the average height of the plants, were significantly greater on the mulched than on the unmulched plots. Nine weeks after planting these differences were even more pronounced. Nevertheless, the ultimate yield of plant canes was the smaller on the mulched plots.

Cane formation did not commence on the unmulched plots until more than a month after the rains set in. The early-formed joints of cane were long and thick. The moisture conserved in the mulched plots led to a certain amount of cane formation before the rains. The joints formed during the dry season were short in length and small in diameter. Although the growth of these canes continued in the following wet season, the sub-normal development of the early-formed joints appears to have adversely affected the ultimate weight of the canes.

The mulch used in this experiment was composed of leaves which had dried out on the plant and were stripped off. Material of this nature is leathery in texture and decomposes very slowly. Consequently it would be unlikely to act as a source of readily available phosphate and potash during the life of the plant.

The information obtained from these two preliminary experiments makes it evident that mulching with trash can give rise to paying results under the conditions which obtain in Antigua, but that further critical experiments are necessary if maximum benefit is to be derived from the operation. To secure optimum results it appears necessary to use the mulch to maintain the early growth made in the previous wet season, rather than to promote growth at a critical stage in the life of the plant under unfavourable soil conditions.

Grassland.

The successful results obtained from one of the experiments on mulching with trash raise the possibility of using other vegetable material, such as grass from waste areas, as a soil cover for sugar-cane during the dry season. Alternatively other vegetable material may be used to replace in part the trash used as bedding in the pens (1). Further, the tendency towards earlier ploughing in Antigua, and the consequent abandonment of 'stock-meat' fields, make it necessary to find other sources of food for stock during the wet season.

There exist in Antigua comparatively large areas of saline clay-tuff soils which are unsuited to sugar-cane and are abandoned to grass. A manurial and cultural experiment has been laid down on this type of soil to determine whether the yield of grass can be economically increased. Four treatments are under comparison on the experimental area, viz. :—

(1) Nil,
(2) Manuring with sulphate of ammonia,
(3) Forking,
(4) Manuring with sulphate of ammonia and forking.

The preliminary effects of treatment with sulphate of ammonia on yield of grass (green weight) are recorded in Table XXIV. The effects of the other treatments will be published in subsequent papers.

The dominant grass on the experimental area is *Andropogon nodosus*. It appears well adapted to the saline clay-tuffs and to the lagoon clays, and is relished by stock. The pH values of the topsoil and subsoil of the experimental area, as measured by the glass electrode, are 7.6 and 7.4 respectively. The soil contains no calcium carbonate.

Table XXIV.—Early effects of sulphate of ammonia on green weight of grass.

Soil type : Non-calcareous, saline clay-tuff.
Estate : Tomlinsons.
Layout : Ten randomised blocks.

Treatment per acre.	Green weight of grass. (tons per acre).		Gain in yield (to date).	
	After 1 month.	After 3 months.	Tons p.a.	Per cent.
Nil ..	2.02	1.55	—	—
2 cwts. S/A	2.35	2.43	1.21	34

The sulphate of ammonia was broadcast on the manured plots at the end of September. The plots were reaped for the first time at the end of October, when the grass was in flower. The rainfall during the interval was 2.25 inches. The plots were reaped for the second time early in the following January. At the time of the second cutting the effect of the dressing of sulphate of ammonia was very noticeable, especially in regard to the number of culms, the height of the culms, and the amount of leaf. The rainfall during the interval between the two cuttings was 12.83 inches.

The effect of treatment with sulphate of ammonia on yield, at the first cutting, cannot be established as significant. At the second cutting it might be due to chance less than once in 100 times. The increase in yield of grass during the first three months after application of the dressing amounted to 1.21 tons to the acre or 34 per cent. of the yield on the unmanured plots. There appears to be little doubt that the yield of grass on abandoned, saline lands in Antigua can be very greatly increased in a comparatively short period by a conservative dressing of sulphate of ammonia.

It is of interest that the gain in yield of grass, resulting from the use of sulphate of ammonia, was obtained on an alkaline soil of pH value 7.6, in the absence of calcium carbonate. A large and significant gain in yield of sugar-cane under somewhat similar conditions is recorded in Table XIII.

Summary.

There are recorded in this paper a preliminary series of results obtained from a scheme of field experiments inaugurated in 1933 under the auspices of the Sugar-Cane Investigation Committee of Antigua. The more important of the results are summarised below.

Varieties.

The variety B.2935 gives promise of competing with Ba.11569 on the calcareous marl soils.

Preparation of the Soil for Planting.

Cross-holing on a heavy soil type was found to have no beneficial effect on yield under conditions favourable to this operation.

Distance of Planting.

No gain was derived from planting at distances in the row closer than four feet on the shallow, calcareous marl soil under conditions of low rainfall.

Cultural Methods after Planting.

Valuable information has been obtained concerning the conditions which prevent benefit resulting from the operation of breaking of banks.

Manuring.

Progress has been made towards solving the difficult problem of manurial treatment of sugar-cane in Antigua, with special reference to the use of inorganic manures.

Sulphate of Ammonia.

(*i*) Sulphate of ammonia can give rise to a significant increment in yield of plant canes with a total rainfall as low as 42 inches, and of ratoon canes with a total rainfall as low as 38 inches.

(*ii*) Sulphate of ammonia can give rise to a significant increment in yield of cane on alkaline soil of pH value 7.65.

(*iii*) The presence of calcium carbonate in the soil in excess can adversely limit, or even completely remove, the gain in yield which can result from the use of sulphate of ammonia when applied alone.

These conclusions are in complete agreement with the results obtained from a series of field experiments in Trinidad. *It should be noted that in Trinidad the adverse effect of calcium carbonate, on the gain in yield to which sulphate of ammonia can give rise, is counteracted by small dressings of readily available phosphate, and in certain special cases by potash.*

Sulphate of Ammonia v. *Nitrate of Soda.*

(*i*) In the absence of calcium carbonate, sulphate of ammonia and nitrate of soda give equally large gains in yield of ratoon canes.

(*ii*) In the presence of excess calcium carbonate both sulphate of ammonia and nitrate of soda fail to lead to gain in yield.

(*iii*) The lack of success which attends the use of sulphate of ammonia on calcareous soils cannot be ascribed to tardy nitrification of the ammonia.

Pen Manure.

(*i*) Pen manure gives rise to significant gains in yield on calcareous soils.

(*ii*) The optimum dressing of pen manure appears to be in the region of 12 tons to the acre.

Filter-press mud.

(*i*) This waste product of the factory can give rise to significant gains in yield on calcareous soils.

(*ii*) The optimum dressing appears to be in the region of three tons to the acre.

It should be noted that pen manure and filter-press mud contain nitrogen and phosphate.

Mulching with Trash.

(*i*) Sulphate of ammonia gave rise to a paying increment in yield of plant canes on a highly calcareous soil in the presence of a mulch of decomposing trash. It is believed that the trash supplied the readily available phosphate, and perhaps potash, necessary to counteract the adverse effect of the calcium carbonate on the gain in yield due to sulphate of ammonia.

(*ii*) Unrotted trash was found to cause a depression in yield of plant canes.

Manuring of Grassland.

The yield of grass on abandoned, saline soils, of pH value 7.6, can be greatly increased in the course of a few months by treatment with sulphate of ammonia.

THE SOIL TYPES OF ANTIGUA.

An agricultural classification of the sugar-cane soils of the island is included in this paper.

Acknowledgments.

The authors are indebted to Mr. A. E. Collens, Government Analyst, and to Mr. M. Moore of the Antigua Sugar Factory, for juice analyses of the varieties recorded in Tables I, II, III and IV.

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EMPIRE-GROWN SISAL FOR MARINE CORDAGE.

The Imperial Institute has recently published (February, 1935, 1s.) a report upon tests carried out in conjunction with the Admiralty of tarred and untarred cordage made from East African sisal. As Manila hemp does not absorb tar satisfactorily, such cordage in the past has generally been made from European hemp. In order to investigate the effect of tarring on the durability of sisal cordage, the Admiralty has recently carried out a further series of experiments. Ropes, three inches in circumference, were prepared from East African sisal, one batch being made in the ordinary way from untreated fibre and another from yarn which had been passed through a bath of Archangel tar. Both kinds of rope were exposed to the action of sea water for periods of two, four, six and nine months, their breaking strain being determined at the end of each period. It was found that after exposure to the action of sea water for nine months, the untarred sisal rope had lost 76 per cent. of its initial strength, whereas the strength of the tarred sisal rope had fallen only 29 per cent. The tests have thus shown that the life of sisal ropes when exposed to sea water is enormously prolonged by tarring. The Admiralty is therefore considering the general adoption of tarred sisal cordage in place of tarred European hemp cordage, and inquiries are being made as to the extent to which such substitution could be carried out.—(*Nature,* Vol. CXXXV, No. 3420, p. 841, 1935.)

CORRESPONDENCE.

VETERINARY LABORATORY,
MINISTRY OF AGRICULTURE & FISHERIES,
WEYBRIDGE, SURREY.

DEAR SIR,

Two complete volumes of *Index Veterinarius* have been published and the first number of Volume III, has just been issued. It would appear to be worth while now to invite the help of those who use the *Index* in order to ascertain whether its usefulness can be increased.

The text has been laid out in a form in which it is hoped that the references can easily be traced. This has involved the adoption of certain nomenclature and systems of classification that may not be used or followed by some readers, though it is believed that the information required is easily found.

Subjects on which, among others, the views of readers would be welcomed are :—

System of classification.
Nomenclature.
Subjects and interests covered.
Additions to or cancellations of publications indexed.
Layout.

I would be glad to receive the opinions of readers on the above points and their views regarding any other improvements that might be introduced.

Yours faithfully,

W. A. POOL,
Editor.

REVIEWS.

PRINCIPLES AND PRACTICE OF FIELD EXPERIMENTATION.

By J. A. Wishart, M.A., D.Sc. and H. G. Sanders, M.A., Ph.D. *The Empire Cotton Growing Corporation*, London, 1935, pp. 100, 3*s*.

Many readers will be familiar with an excellent paper entitled "The Principles and Practice of Yield Trials" which appeared in the *Empire Cotton Growing Review* in 1926. This article summarised in a concise and lucid manner the salient features of field experimentation up to that date. During the ensuing ten years, largely as a result of the statistical methods promulgated by Fisher, the technique of field experiments has been practically revolutionised, and the pamphlet under review is essentially a sequel to the earlier paper brought up-to-date and includes all the recent advances both in lay-out and statistical interpretation. While experimental methods have improved, they have also become decidedly more complicated, and in order to cover the ground the publication has had to be considerably enlarged, extending to one hundred pages.

It is divided into two sections. The first half is devoted almost entirely to a synopsis of statistical principles and their application to yield data. From the estimation of a simple standard deviation, it progresses through various stages to the analysis of variance and covariance of relatively complex experiments. The only omission appears to be 'confounding', and this has been left out intentionally as it is still in the experimental stage. In this statistical section, the authors obviously assume that the reader has a reasonable grounding in the principles of the subject. In consequence, the novice will find this first half exceedingly difficult to follow. For those with some previous experience of statistical procedure, it undoubtedly provides an excellent summary of the various ways in which the data from field experiments may be analysed and a correct interpretation of the results obtained.

The second half is a much needed exposition of the various practical problems that arise in connection with the field side of agricultural experiments. This represents the fruits of many years' experience, and the authors are to be congratulated on having accumulated under one cover a great deal of valuable information, which is not generally emphasised sufficiently in the average run of publications on this subject. There is rather a tendency today to forget that statistics applied to experimental data are merely a means of arriving at correct deductions, and it is with pleasure that the reviewer notes that stress has been put on the need of making the statistical treatment the servant of the biological. The value of developmental studies and observation plots is also very advisedly discussed at some length.

The book is written from the British standpoint, and fuller details on the peculiarities of experimentation with perennial and orchard crops would have been welcome to the agriculturist of the tropical zone. The general principles are of universal application, and the authors deserve great credit for having managed to cover their subject so effectively in the limited space available. The book forms an excellent resumé of the existing state of our knowledege of field experimentation from both theoretical and practical aspects.

D. D. P.

* * *

A BIBLIOGRAPHY OF SOIL SCIENCE.

The Imperial Bureau of Soil Science has recently issued a complete "Bibliography of Soil Science, Fertilizers and General Agronomy."* covering the whole scientific literature of the world on soil and allied sciences during 1931-34. This extremely comprehensive bibliography gives the reference to practically every paper published during that period on the different branches of soil science, both pure and applied, on the use of fertilizers, on the cultivation of all the chief economic crops (over 140, including forests, are listed in the index) and on plant diseases in relation to soils. The references are arranged by subjects according to the Universal Decimal Classification, which is adequately explained in the Preface. The volume also contains an index to the Decimal Classification, an alphabetical cross-index to every subject on which the papers listed have been written, an author index containing over 4,000 names, and a list of the abbreviations used, and the full titles and places of issue (where known) of 800 journals, &c., from which the references in the Bibliography have been taken. The literature of almost every country has been covered, thanks to the exceptional facilities for procuring foreign periodicals which the Soil Bureau enjoys. Considering its scope and the amount of information it contains, the book has been made remarkably compact, without detriment to its readability. It should be a most valuable reference book to every agricultural scientist whose work is in any way connected with the soil. The Bureau intends to issue further similar bibliographies at intervals of three to four years, and in this way gradually to build up a complete reference library to the whole literature of the soil over an extended period of time.

* Crown octavo, pp. 504. Bound in cloth, with gold lettering, price 25*s*. net, post free from the Imperial Bureau of Soil Science, Harpenden, England.

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.
Academic Staff and Students 1935-36.

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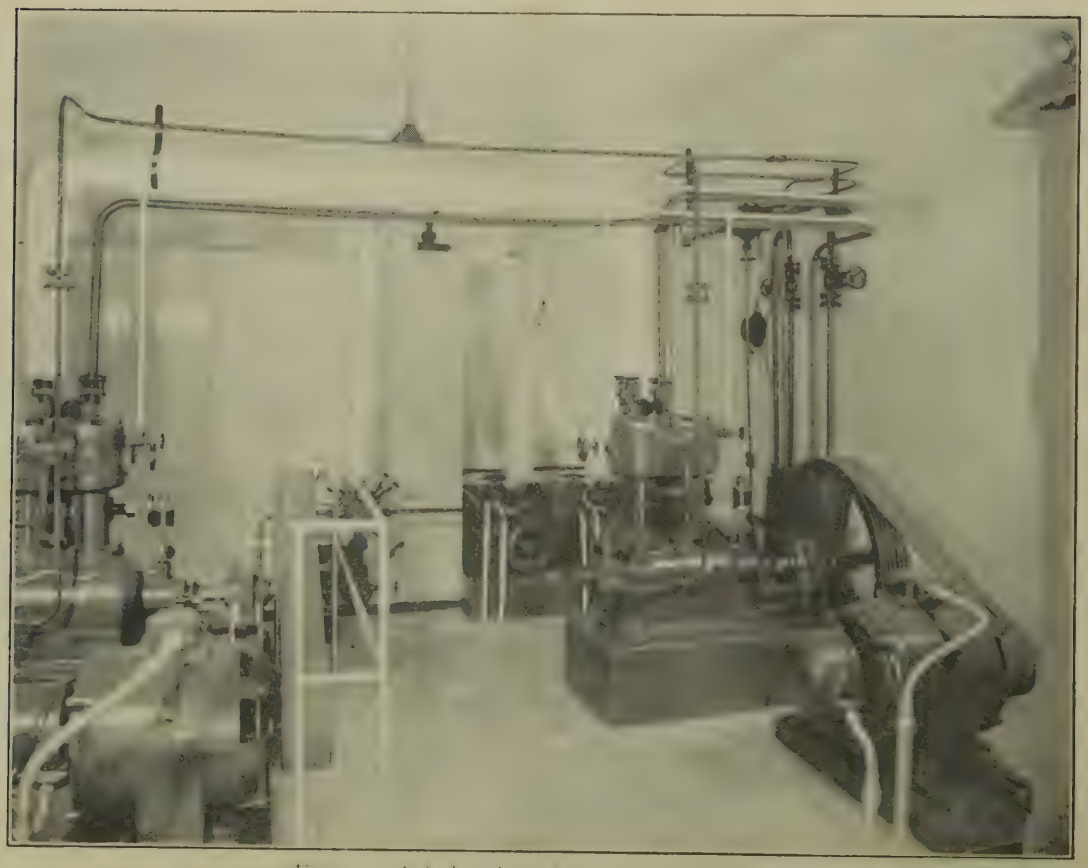
Absentees : C. C. Skeete, H. V. M. Metivier, J. G. Myers, P. Sauvage, S. Khan, J. Prasad.

NEW LOW TEMPERATURE STATION, JAMAICA.

FIG. 1. *General View: Packing house on left. Cold Storage Building on right.*



THE NEW LOW TEMPERATURE STATION IN JAMAICA.*

THE New Low Temperature and Marketing Experiment Station which was recently opened by Sir Edward Denham for the Department of Agriculture in Kingston forms part of a development scheme for the banana, citrus, and minor fruit and vegetable industries of Jamaica which was planned early in 1933 and approved by the Legislative Council.

The Low Temperature building consists of a compressor room, and of four insulated rooms, each of 750 cubic feet capacity, capable of independent operation. Each pair of rooms is served by an air lock. In three of the rooms the cool air circulation is from wall to wall and in the fourth from floor to ceiling. Provision has been made for both automatic and manual control of the compressors; and air temperatures are regulated by a thermostat system. A 32-point electrical thermometer by Negretti and Zambra is installed in a case on the outer wall on the verandah and enables direct temperature readings to be taken at a number of points in each room. Subsidiary to the Low Temperature building are an office, laboratory, packing house and store. The station cost approximately £3,800. It was erected and the equipment installed by the Henriques Brothers Construction Company of Kingston; the machinery and equipment being supplied by Messrs. J. and E. Hall, Limited.

In addition to examining fruits and vegetables under low temperature conditions it is proposed to use the station for the preparation of experimental shipments for the Department and small commercial shipments for growers. It is not intended that the work of the Station should in any way duplicate that being conducted at the Low Temperature Stations in Cambridge and in Trinidad. Rather is it desired to supplement the researches being carried on there by a well-planned series of investigations on storage and transport problems which are of local importance. It is proposed that the staff at the Station should maintain contact with the other institutions, and it is hoped that, as a result, the study of a wide range of important low-temperature problems in connection with Jamaica's fruit and vegetable industries may be more rapidly proceeded with.

Mr. F. E. V. Smith, B.SC., Government Microbiologist of Jamaica, is in charge of the Station, the rest of the staff consisting of two Agricultural Officers, two Technical Assistants, one Mechanic and an Electrician.

* Compiled from an article in the *Crown Colonist*, October, 1935, p. 458, by Mr. A. C. Barnes, Director of Agriculture, Jamaica and also from an official communication from Mr. Barnes.

PARASITISM OF RHIZOCTONIA LAMELLIFERA, *SMALL*

IN the years preceding 1929, much controversy existed regarding the parasitism of the group of fungi known collectively as *Rhizoctonia bataticola*. The differences of opinion held by various sections of workers, and postulated principally by Small, Gadd and Briton-Jones, were largely attributable to the use of the one specific name *bataticola* for what now appears to be a relatively large group of sclerotium-forming fungi. Papers published by Ashby (1) in 1927 and Haigh (2) in 1930 showed that *R. bataticola* was a polymorphic fungus possessing a pycnidial stage, *Macrophoma phaseoli*, and was apparently distinct from two other forms which Haigh styled strain *A* and strain *B*. In 1933, I showed (3) that strain *A* was physiologically and morphologically distinct from both strain *B* and *M. phaseoli*, and suggested that it should be designated by Small's original binomial *R. lamellifera*. The question of parasitism I did not touch upon.

For the past eight years I have been experimenting with the object of producing infection in young plants by various strains of these fungi, but until a year ago was unable to obtain any certain results with *R. lamellifera*. Last year, however, by growing grapefruit seedlings on certain agar media under aseptic conditions and inoculating with a grapefruit strain of *R. lamellifera*, I obtained 100 per cent. 'kill' in 24 plants after nine weeks. Control plants on sterile agar and on media inoculated with (*a*) *M. phaseoli* and (*b*) a saprophytic *Phyllosticta* sp. remained green until after the agar had dried out—a matter of six months.

Infection was observed to begin at the root tip and proceed along the translucent roots for several inches when the plants began to wilt. Soon afterwards the fungus growing on the surface of the medium, attacked the seedling at the 'collar' and very soon invaded the whole of the stem and leaves causing the plant to die rapidly. A contributory factor appears to be water shortage.

Preliminary histological examination suggests that the fungus advances along the vascular system of the young root and does not penetrate the cortex except to form sclerotia.

Confirmatory evidence of parasitism under specialised conditions was obtained in later experiments.

There appears to be no authentic record of *R. lamellifera*, as distinct from members of the *bataticola* group, killing living plants, and as a number of workers have recently turned their attention to this group of fungi, it might be well if my experimental results were made known pending the publication of a full paper.

(Letter from J. C. Hopkins, Senior Plant Pathologist, Department of Agriculture, Salisbury, Southern Rhodesia, published in *Nature*, Vol. CXXXIV, No. 3395, pp. 812-813).

(1) *Trans. Brit. Myc. Soc.*, 12, 141; 1927.
(2) *Ann. Roy. Bot. Gard.* Peradeniya, 11, 3; 1930.
(3) *Proc. Rhodesia Sci. Assoc.*, 33, 65; 1933.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Lime Requirements of Coffee Soils.

Since the establishment of the Coffee Experiment Station at Balehonnur a great deal of attention is being devoted to problems connected with the coffee industry and a study of the lime requirements of coffee soils was one of the items taken up.

Periodical application of lime to coffee estates had been in practice for some time before the study was taken up here. Analyses of virgin coffee soils and experience reported from other countries gave the clue that the coffee bush flourished best when the soil was just neutral or very slightly alkaline in its reaction.

While touring in coffee areas during 1925, it was observed that arrangements were being made to apply lime to a group of estates of over 1,000 acres. The rate of application was roughly estimated by the owners at about 10 cwts. per acre. On going over the estates in detail, it was found that the soil was by no means uniform throughout the whole group of estates nor was the condition of plants uniform over the whole area either. It was thought worth while to test the soils in detail for their reaction. The whole group was divided into blocks varying between five and ten acres, according to nature of soil and condition of plants at the time. Soil samples were taken from every acre to a depth of six inches, mixed together to obtain a representative sample for every block and tested on the spot by using the B.D.H. soil testing outfit. The reaction was found to vary very widely from fairly acid to neutral. Taking into consideration the condition of plant as well as soil reaction, application of lime was varied to bring the reaction just to neutrality. Instead of a contemplated uniform dose of 10 cwts. per acre, it was found advisable to vary the application from nothing to two tons per acre. The lime was not applied as caustic or quick-lime but as carbonate obtained by slaking it and exposing it to the action of air for over a month. The results were on the whole satisfactory. Thousands of acres have been limed in this way since 1925 and results found to be satisfactory.

Later on, sand culture studies in pots were made to find out the relation between reaction of soil and growth of coffee. The required reaction was brought about by the addition of acid or alkali to the nutrient solution as well as water used for irrigating the plants. This kind of differential treatment was started after young coffee plants had become well established in the pots.

During a period of one year the plants developed marked differences in growth, and the best development was observed in pots maintained at a neutral reaction. The development was best not only with regard to visible portion of the plant above ground but also in its root portion which was also studied after removing the plants and washing out all sand from the roots. These experiments are being repeated on the Coffee Station itself in natural soil enclosed in cement cisterns and in which coffee is growing under natural conditions.

The scale worked out for application of lime on coffee estates after testing the soil corresponds fairly well with the results obtained from sand cultures in pots.

Other conditions being satisfactory, the lime requirements of coffee soils seem to vary between nothing and three tons per acre. Those interested in liming their estates may apply to the Agricultural Department and requests for testing soils will be complied with as far as time and staff permit.—(*Mysore Agricultural Calendar.*)

* * *

Manuring of Bananas.

Investigations by Teissonier in French Guinea have shown that the most successful manurial formula for bananas is 6 per cent. nitrate, 10 per cent. phosphoric acid, 11 per cent. potash, 8 per cent. lime. In addition to chemical manures stable manure or oil cake or some other form of humus forming material should be applied.—(*Horticultural Abstracts*, Vol. V, No. 2, Abs. 295, p. 106, 1935.)

* * *

Rubbone.*

When rubber ages, it first becomes soft, then cracks and gradually becomes hard and brittle. Chemically, the rubber has oxidized and great efforts have been made to prevent oxygen-vulcanized rubber. Rubber tires have carbon black in their composition partly to reduce transparency and thereby to protect them from sunlight, and anti-oxidants which are added in small amounts to prevent combination with oxygen. In England they are making oxidized rubber intentionally and are trying to find uses for it. This oxidized rubber has been named "Rubbone" and is produced by milling pale crepe rubber, 20 parts of which is made into a paste with 80 parts of kerosene and ½ part of cobalt linoleate added. The mixture is heated to 160°F. and then airblown until a sample drawn off settles rapidly, leaving a clear, thin solution of the oxidized rubber. The whole is then clarified and the solvent driven off by steam distillation, leaving the resinous rubber product. Oxidized rubber is a sticky semi-solid that will just pour at ordinary temperatures. If kept hot for a relatively long time (24 hours at 280 F°.), it "thermo-sets". It appears to be of value for the impregnation of coils of wire, which after baking until thermo-setting leaves the wire embedded in an elastic solid insulator which case-hardens on the surface so that it is non-tacky. Attempts are also being made to use Rubbone in paints for adhesiveness and good undercoat properties.—(*Jr. of Chem. Education*, Vol. XII, No. 11, p. 545, 1935.)

* *Ind. Bull. Arthur D Little, Inc.* 103, 4, 1935.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

British Guiana Sugar Industry.

According to the Report of the Director of Agriculture, British Guiana, for the year 1934, of the total of 61,567 acres allocated to cane in 1934, 52,194 were reaped on the estates. The estates yield averaged 2.49 tons per acre. The lower output as well as lower average yield when compared with the two previous years was due to the disastrous floods of December-January, 1933-34, and of the severe drought which followed. Diamond 10 and POJ 2878 are being increasingly planted and D 625, though still the most prevalent variety, is being gradually decreased. Of the acreage to be reaped in 1935, 55.4 per cent. is planted to D 625, 22.7 to Diamond 10, and 4.7 to POJ 2878. The floods took a heavy toll of the sugar experiments and no less than 15 had to be abandoned while several others were severely damaged. In general, experimental work has received a setback which will retard the accumulation of data urgently required.

The annual output of cane farmers is gradually expanding and will show a further rise for 1935. The sugar estates continue to pay a minimum price of $2.20 per ton of cane, which is well in excess of what farmers would have received under the agreed schedule. An effort is being made to establish nurseries of POJ 2878 and D 10 in cane farming areas. (*Extract from Int. Sugar Journal*, Vol. XXXVII, No. 444, p. 485, 1935.)

* * *

Entrainment in the Multiple Effect Evaporator.—*J. L. Halpin.*

Of the many types of entrainment traps the Stillman apparatus is a very efficient type, and although the high first cost appears to have been an obstacle to its use in Australia, it is largely used in other countries; while the Umbrella type entrainment preventer, when properly designed, is very effective. In its best form, it consists of a horizontal base plate fitted with an attached vertical tube and over the latter is a centrally mounted plate in the form of an umbrella. The whole trap should be mounted as high in the vessel as space will permit. In operation, the vapour rising through the tube at high velocity strikes the umbrella and is compelled to turn sharply outwards and slightly downward; the vapour immediately passes into an area where its velocity is greatly reduced, but the heavier drops of liquor maintain their velocity long enough to be projected into an area where the vapour velocity is very much lower. Consequently the drops of liquor have a tendency to fall by gravity on to the top side of the horizontal plate from which they are drained by suitable pipes or baffles slots placed near the walls of the vessel. Every evaporator should be provided with some means of ascertaining whether serious entrainment takes place, and the following has been found effective for the purpose: Two semi-circular plates are cut to fit the vapour pipe, and should be about two inches over a true semi-circle with a ledge across the straight edge of the plate of say two inches wide set at an angle of 45° off the plates. The first plate (that nearest the effect vessel) is bolted to the top of the horizontal section of the vapour pipe; and it should have the ledge cut away for about ¾-in. at one end in order that any entrapped vapour may run to the bottom of the vapour pipe. The second plate should be fastened to the bottom of the vapour pipe, angle rings and bolt forming a suitable means of attachment. These baffle-plates should be spaced at such a distance that the vapour passage is equal to about one-half of the area of the vapour pipe. A short length of 1½ inches gas pipe is tapped into the bottom of the vapour pipe immediately before the second baffle-plate, being reduced to a ¾-inch pipe leading into a small receiver (of say two gallons capacity), fitted with sight-glasses and with drainage pipes and cocks. This device makes it possible to detect whether serious entrainment is taking place, and whether it is constant or intermittent.—(*Int. Sugar Journal*, Vol. XXXVII, No. 444, p. 489, 1935.)

* * *

Gur or Jaggery.*

Gur contains anything from 60 to 85 per cent. of sucrose; it is most nearly described as hard-boiled massecuite. This is the form in which some three and a half million tons are now consumed annually. In colour, purity, hardness and flavour it varies greatly from tract to tract, but, with relatively unimportant exceptions, it is not a raw refining sugar, but a final product for domestic consumption. It is made in most sugar cane growing villages by the simplest processes. Modern 2-roller and 3-roller iron mills, and to a limited extent larger 3-roller and 5-roller mills, driven by oil engines, have replaced the earlier pestle-and-mortar type of mill made of stone or wood. Quite appreciable improvements have also been made in the furnaces and pans, but in essentials the process is much the same as it was a hundred years ago, the fresh cane juice being boiled down to solidifying point in an open pan. A certain amount of clarification takes place during this process, and multiple pans are common in some tracts where high-class *gur* is made. It should be added that the estimates of production of sugar and sugar cane in India are always expressed in terms of *gur* and that in the crop-cutting experiments on which the standard yields are based, the yield of *gur* per acre, and not cane, is recorded.—(*Int. Sugar Jr.*, Vol. XXXVII, No. 442, p. 405, 1935.)

* Extracted from a lecture delivered by B. C. Burt, Expert Adviser, Imperial Council of Agricultural Research, India, before the Royal Society of Arts, London, on 31st May, 1935.

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.).

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
28th November	5	0	8	9¾
5th December	5	0¾	8	9
12th December	5	0¾	8	9
19th December	5	0¾	8	10½
27th December	5	1½	9	0
2nd January	5	1½	9	0¾
9th January	5	1½	9	0¾
(10th January, 1935)....	4	6	8	3¾

The tone of the market in London has continued very steady and values have been maintained at around previous levels, raws showing a slight improvement. In New York conditions are rather unsettled owing to the uncertainty in regard to existing sugar legislation. During 1934-35 there was a definite improvement in the world statistical position. According to figures compiled by Dr. Mikusch world consumption overtook actual production to the extent of over 700,000 tons and was 2.4 per cent. higher than in 1933-34.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
27th November	5 5-16
4th December	6 1-4
11th December	6 3-8
18th December	6 3-8
24th December	6 7-16
31st December	6 7-16
8th January	6 5-8
(9th January, 1935)	6 11-16

The announcement that the basic Dutch East Indies quota for 1936 was increased by 57,000 tons to 500,000 tons caused a minor setback of values. The undertone of the market is, however, steady. Consumption in U.S.A. for the month of November 1935 was 42,777 tons, the total consumption for eleven months being 454,206 tons or 8¼ per cent. higher than in 1934.

* * *

COPRA.—West Indian f.m.s. has been firm and the price is 5*s.* per ton higher at £14 15*s.* c.i.f. London.—(*West India Committee Circular*, 19th December, 1935.)

COCOA.—Since last writing the cocoa market displayed considerable strength and despite the interruption because of the Christmas Holidays, the demand continued unabated. This was caused by 'shorts' covering. In consequence warehouse stocks declined moderately, and it is expected these will be further reduced. Accra cocoa is quoted at 23*s.* 3*d.* c.i.f. and locally $6.90 per fanega is paid.—(*By Courtesy of the Cocoa Planters' Association of Trinidad Ltd.*)

* * *

COTTON :—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
29th November	6.59	10.14
6th December	6.67	10.18
13th December	6.50	9.66
20th December	6.38	9.43
27th December	6.45	—
3rd January	6.39	—
10th January	6.18	—
(11th January, 1935)	7.18	9.01

The Market has been rather unsettled by political events, the silver situation and the uncertainty in regard to the future of the processing tax and the Bankhead Act. Values for Raw Cotton have been marked down and there has also been a fall in Egyptian Sakel. The price of West Indian Sea Island continues firm at 18*d.* to 19*d.* per lb.

* * *

BANANAS.—There has been a good demand at the unchanged price of £20 5*s.* per ton delivered London and £20 nearest station Provinces. Brazilians are quoted at £16 delivered nearest station.

* * *

LIME PRODUCT .—*Lime Oil.* Handpressed is quiet and unchanged: the last price was 35*s.* per lb. *ex* wharf. Distilled is unchanged at 22*s.* 6*d.* per lb. and slow of sale. *Lime Juice.* Concentrated continues to be quoted at £4 15*s.* Raw is steady but slow of sale at 2*s.* to 2*s* 6*d.* per gallon for good to fine.—(*West India Committee Circular*, 19th December, 1935.)